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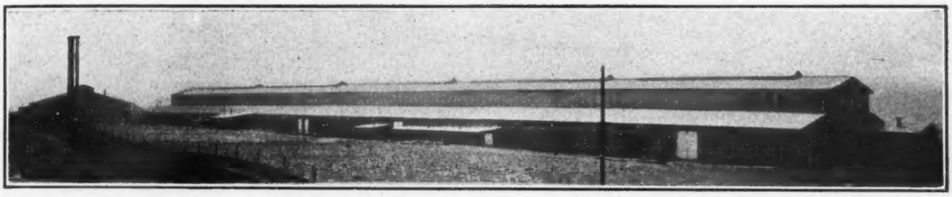


FIG. I. MAIN BUILDING AND POWER HOUSE, CAMERON PUMP WORKS.

A MODERN PLANT FOR BUILDING PUMPS

BY CHAS. A. HIRSCHBERG.

To take care of the ever increasing demand for its product, the A. S. Cameron Steam Pump Works recently erected a new shop, at Phillipsburg, N. J., which is typical of modern practice, in shop construction.

Many novel features are to be found in this plant, and it is the object of this paper to describe these, as well as the characteristic features of design contained in the Cameron product.

The Cameron Works have grown from a small one-room shop, started in 1860, located at the corner of 22nd St. and 2nd Ave. in the City of New York, embracing approximately 400 square feet of floor space, to its present extensive modern quarters, giving employment to many men in different departments and providing for future growth and development.

It is interesting to note the growth attendant upon the manufacture of a product greatly limited in its early scope, to one that is now found as an accessory to many other mechanical contrivances in various fields. This product has earned a world-wide reputation for quality and efficiency and it is obvious that true merit alone could be responsible for such growth, both in plant, and the recognition accorded the product as the standard line of pumps, for mining, contracting, boiler plant, sugar industry and general industrial and manufacturing purposes.

As already stated, it was in 1860 that the A. S. Cameron Steam Pump Works was founded, by Adam Scott Cameron.

In 1863 Mr. Cameron formed a partnership with William Sewell, at that time a Chief Engineer in the U. S. Army, and together, they produced what was then known as the Sewell & Cameron Crank and Flywheel Pump. This pump met with such great demand that it became necessary to increase the size of the plant at that time. In 1865 the partnership was dissolved by the death of Mr. Sewell and the business continued under the direction of Mr. Cameron.

That year saw the advent on the market of a new pump, namely, a crank and flywheel dry vacuum pump, used in connection with the process of sugar boiling. Remarkable economies were effected with this pump, over the former methods and means used in the sugar industry.

In 1868 it again became necessary to seek larger quarters, and the plant was accordingly moved to a three-story building at the foot of East 23rd St. This building had a frontage of 100 feet and was 200 feet deep.

About this time experiments were completed by the Cameron Works on a double-acting, Horizontal, Piston Simplex Pump, embodying a distinct departure from all contemporary design, in that there were no outside moving parts, but the entire operation of the pump was controlled by an enclosed steam thrown valve. Its simple design, rugged, fool-proof construction and efficient operation, appealed so strongly to users of pumps, that it became an immediate favorite, and was largely adopted as a boiler feeder in power plants, for pumping oil in the oil fields, and general mine service.

This type, in fact, became the nucleus for a line of pump types, largely responsible for the popularity of the Cameron. Among these may be mentioned the long stroke pattern, for rolling mills and blast furnace service, a special oil-line pattern, for the oil fields, and which design embodies a removable bushing; a vertical piston pattern, for shaft sinking and a horizontal plunger pump, for handling gritty water in mine station work. These and many others were built around the first original design, each embodying its best features, with modifications, to meet the various service to which each was to be applied.

In 1877 Mr. Cameron's death occurred, due to gradually failing health. To this date the business had grown to such proportions that several additional buildings were required, until the whole plant covered a plot of ground 325x200 feet, occupying nearly three-quarters of the block bounded by 23rd and 24th Sts. and Ave. A and 1st Ave., in the City of New York.

The business was continued under the administration of the Cameron Estate. Many new types of pumps were added to the line, notably, the vertical plunger pattern, for shaft sinking, a recognized leader to-day for this class of work.

Frequent installations of new and improved shop machinery were made and additional space secured, but in 1910 the business had far out-grown the manufacturing facilities and it was decided to erect the new and modern plant now located at Phillipsburg, N. J.

The Phillipsburg Plant shown in Fig. 1 consists of one main building, 100 feet wide by 600 feet long and a number of auxiliary buildings. The main building is of the Central Bay type, and is 50 feet wide at this point, while the wings are each 25 feet wide. The main bay is traversed by a ten ton Shepard Electric Crane, taking current from a side trolley. In addition to this large Crane, there are a number of small three ton traveling Cranes, equipped with electrically operated hoists, operating in the wings. Fig. 2 shows a view of the Central Bay as well as the Shepard Traveling Crane. The moving proposition in this plant is a comparatively simple and easy one, due to the splendid provision made, and hand trucks are but very little required.

The building itself is of structural steel, brick and concrete, and, as will be noted from the illustrations, is particularly well lighted at the roof and sides. This is further augmented by the white painted walls and steel work.

At the front end of the building is located the factory office, occupied in part by the general force and by the Engineering Department. This is also shown in Fig. 2, while Fig. 3 is a view in the Engineering Department.

In the left wing is situated an especially well equipped tool room, caged off from the rest of the shop and with provisions for growth for some time to come. This is shown in Fig. 4. In this wing is also located the brass room shown in Fig. 5, where all work, embodying the use of such metal, is performed.

Beyond this is located the main erecting floor, with its accompanying tool benches and laying out tables. The entire shop is piped with compressed air and there are a number of uses to which this power is put in the Erecting Department. Among the pneumatic tools employed are found chipping hammers, Little David Pneumatic Drills, and various pneumatic testing appliances. Compressed Air is largely used for cleaning castings as well as operating tools. Fig. 6 shows the Erecting Department.

A rather novel application of a pneumatic drill is shown in Fig. 7. All studs are seated in the cylinders by means of such tools, effecting considerable economy over the hand ratchet stud seating tool, generally employed. Fig. 6, already referred to, shows a number of light swinging arms and trolleys which are employed in connection with these drills. The tool is suspended by means of a wire rope and small pulley, with a counterbalance weight, making the apparatus easy to handle.

Just to one side of the middle of the Central Bay are located the testing pits, with their

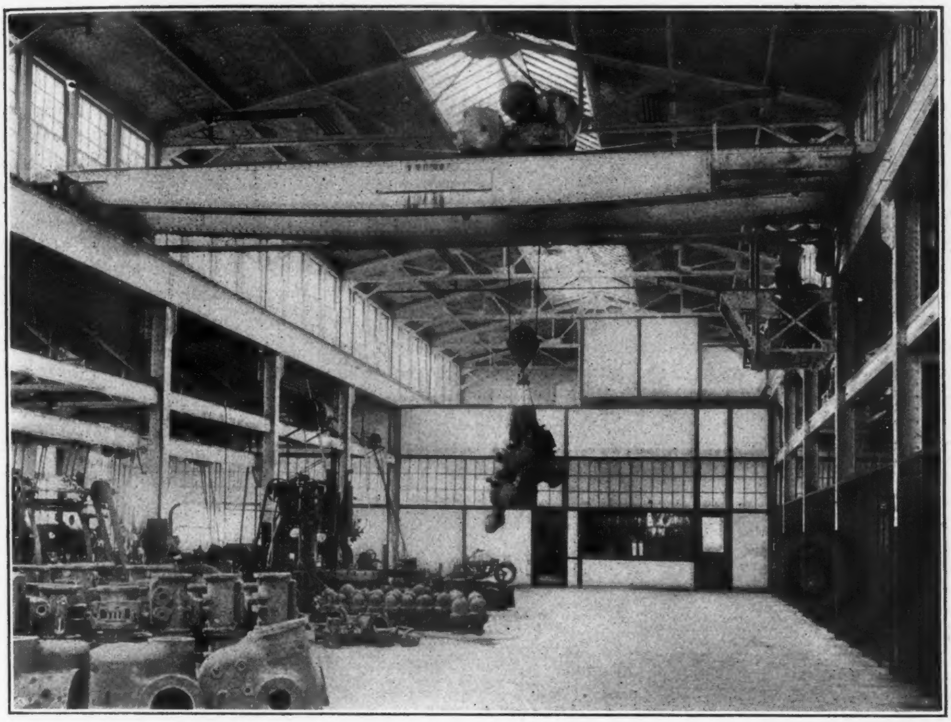


FIG. 2. CENTRAL BAY AND SHEPARD TRAVELING CRANE.

accompanying equipment, of which we will have more to say.

In the right hand wing is the store room, shipping department and lathe department, together with a number of batteries of drill presses and semi-automatic Potter & Johnson machine tools. Fig. 8 shows this department.

Projecting into the main bay are a number of large boring mills and planers, capable of handling the very largest class of pump work.

It will be noted from the illustrations that all the large machine tools are individual, motor driven, whereas, the smaller machine tools are grouped in sets, by classes, and driven from main individual line shafts operated by separate motors. These motors have been installed in a rather novel manner; they are suspended overhead, materially reducing the length of belt drive. Two very important things are gained by this method of installation; first, floor space is saved and left unencumbered by motors and drives; second, the electrical equipment is placed out of harm's way and is readily accessible should occasion require.

In Fig. 9 is shown the locker and wash room located in a supplementary building. The provision made for the comfort of the employees has been given a great deal of thought and here in this room are to be found individual steel lockers, wash basins, supplied with hot and cold water, etc.

Throughout the shop are conveniently located sanitary bubble drinking fountains, the water for which purpose is pumped from an 800 foot deep well, operated by an Ingersoll-Rand Air Lift.

The shop is heated by exhaust steam, and electrically lighted by numerous arc lamps and individual machine tool lamps.

In the shipping department, platform loading has been arranged for. The cars are switched into the building on a sunken track.

The work generally has been standardized by the employment of jigs, so as to insure the interchangeability of parts, while numerous templets and gauges are employed, assuring correct workmanship.

Fig. 10 shows one of these numerous special jigs applied to a boring mill. This jig is em-

ployed for chucking the oddly shaped, centrifugal pump casings. The jig is bolted to the bed plate in the usual manner. Two arms "A" have planed surfaces on which the casting is set. At "B" are located set screws, by means of which the casting is leveled, while at "C" are located dogs by means of which the casting is clamped to the jig, after leveling, and preparatory to facing the casting.

The provision for testing both the direct-acting steam pumps, the centrifugal, motor and power driven pumps is most complete. A 62 feet long by four feet wide, cement lined trench, is provided for testing Cameron Simplex Pumps, with a 30 feet deep well at one end, for testing the suction lift of the pumps, special connections at the bottom, with control on the surface, being provided to regulate the depth of water in the well, for various suction lifts. The above mentioned trench is connected to a further trench, 6 feet wide, encircling the centrifugal testing plants, so as to take care of the overflow. The capacity of this trench is 44,500 gallons. The steam portion of this testing department is such, that a great many pumps may be tested at one time, depending, of course, upon their size. Fig. 11 shows several pumps undergoing test and at the top of the picture may be seen the two steam lines, one a high pressure and the other a low pressure, also an air line for testing pumps that are to be operated by compressed air. Provision is made at the boiler for obtaining either high or low steam pressure.

Figs. 12 and 13 show the equipment for testing centrifugal pumps. The maximum testing capacity is 350 horse power.

Three weir tanks are provided, the smallest having sufficient capacity to test pumps up to 4" discharge, the next larger to test pumps up to 6" discharge, while the largest tank has a capacity of 16,000 gallons. The large weir tank presents a unique feature of design in the use of an adjustable weir gate obviating the necessity for changing weirs, when different sized pumps are to be tested. This consists of a swinging weir gate in several hinged sections, which are swung into place as occasion requires. A view of this apparatus is shown in Fig. 12.

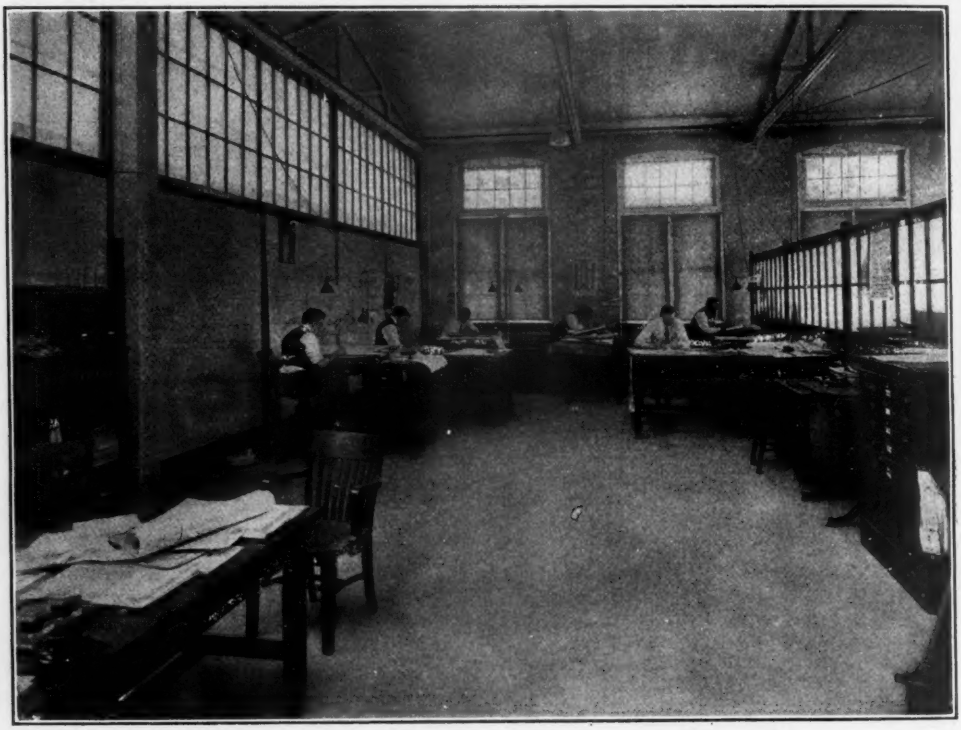


FIG. 3. CENTRIFUGAL PUMP ENGINEERING DEPARTMENT.

Special Torsion Dynamometers, designed for measuring the power transmitted to the centrifugal pumps, is used in this department.

Fig. 14 illustrates this device, which is used to couple the shaft of the driving motor directly to the pump. The ends of the driving and driven shafts are securely coupled together by the shaft "G." This shaft, therefore, has to transmit the power from the one machine to the other and in consequence is subjected to torsion. The shaft referred to is of course designed so that the yield point will not be exceeded.

The various parts attached to the shaft "G," serve partly to indicate the angle of twist and partly to prevent it from being twisted excessively, due to overloading. For reading the angle of twist, three discs, "M," "N" and "O," have been provided. The disc "M" is fixed to the end "H" of the shaft; "N" and "O" are fixed to the end "F" of the shaft. The disc "O" has a radial slit "P." To the disc "M" is attached a transparent celluloid rim "U" on which divisions are cut. Directly opposite to the slit "P" in the disc "N" is a small window provided with a fine slit "T."

When the eye at "Q" looks through the slit "P" the slit "T" is seen as a streak of light and the divisions show black on the scale "U." Slit "T" serves as a pointer, indicating the relative motion of the two discs "N" and "O" as compared to the disc "M." The line of vision is perfectly defined by the two slits "P" and "T;" parallax is therefore impossible when reading the scale and the observation is independent of the distance between the scale "U" and the slit "T." It is apparent that when the apparatus is stationary and the shaft is twisted, the angle of twist will be shown by the movement of the pointer "T" over the divisions on "U." But this pointer and divisions is also visible, when the instrument is running; in fact, they are clearer and more defined than when the instrument is at rest, for while it is necessary to place the eye close to the slit "P" when the instrument is at rest to see the pointer and the scale, it is not necessary to do so when the instrument is in motion, the scale

FIG. 3. STEAM PUMP ENGINEERING DEPARTMENT.

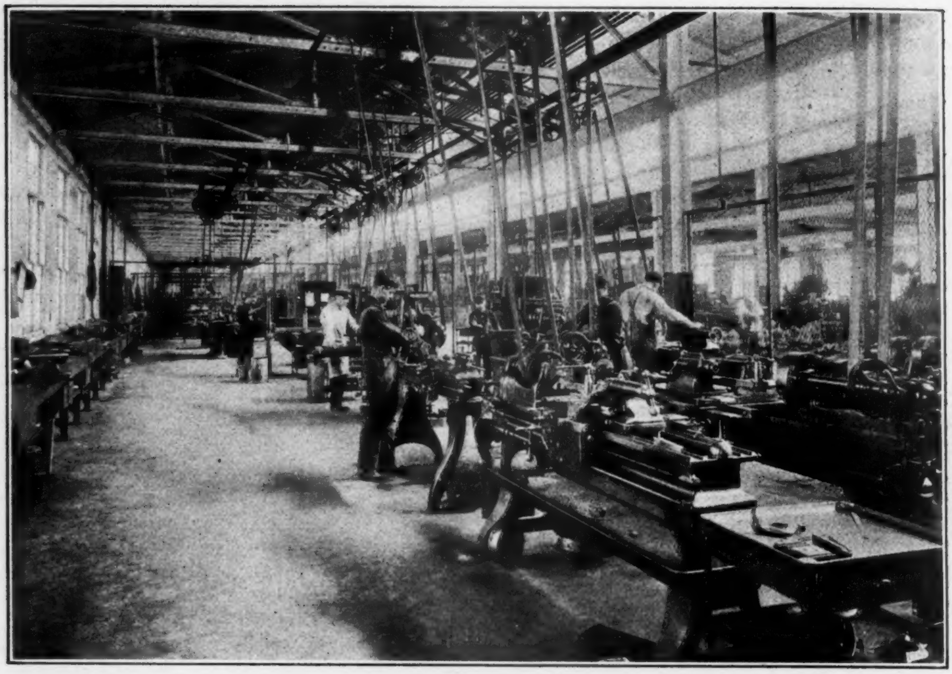


FIG. 4. TOOL ROOM.

FIG. 5. BRASS SHOP.

FIG. 6. ASSEMBLING DEPARTMENT.

being readable at some distance from the slit "P."

To obtain a permanent impression on the eye the scale is subjected to a strong light.

Since the shaft and the other parts connected to its extremities have no tendency to move, due to the centrifugal force, the readings of the dynamometer are independent of the speed. The instrument can therefore be run at any desired speed, provided no forces are set up greater than can be resisted by the material of which the discs are made.

It will be readily seen from the above description that the results obtained from the dynamometer are very accurate, in determining the horse power input of the pump, and that its action is entirely independent of losses due to belt slippage, etc., when the pump is undergoing a power driven test."

The writer acknowledges his indebtedness for part of the above description, covering the dynamometer, to an article which appeared in the September 5th, 1911, issue of Power.

All Cameron Pumps are given a very rigid test and must be up to a fixed standard of efficiency, set by the Cameron Engineers, before they are considered fit for shipment; a complete record of all pumps being kept on file for ready reference. This is just one of the many refinements that have gone far towards making the Cameron product a recognized standard for quality and efficiency.

From Fig. 15 some idea may be gained of the important part played in this shop by quantity production. It enables the manufacturers to guarantee absolute interchangeability of parts, the very promptest delivery, and at the same time enables them, coupled as this product is, with a superior class of workmanship and material to give the purchaser a high class product at a comparatively low price.

In the foundry shown in Fig. 16 the most up-to-date practice prevails. Pneumatic shakers, rammers, etc., are employed, insuring a superior quality of product.

The power plant is located in a separate building, electrical current being generated by a 125 horse power, Compound, Cooper Corliss Engine, direct-connected to a Crocker-Wheeler D. C. Generator, generating 100 KW., 400 Ampere, the voltage being 250. This generator set alternates with a belt driven Westinghouse D. C. generator of 70 KW., 280 Ampere, 250 Volts capacity, driven by 95 horse power, Fishkill Corliss Engine. At times when the load is heavy both sets are operated.

In the engine room is also located an Ingersoll-Rand Class "NF-1" steam driven air com-

pressor of 179 cubic feet capacity when operated at 200 RPM. Just outside of the engine room is a large vertical air receiver. This equipment furnishes sufficient compressed air for the various pneumatic appliances used throughout the shops.

The boiler plant contains the following equipment: two 130 horse power Sterling Boilers and one 100 horse power Sterling Boiler, each equipped with Jones Mechanical Underfeed Stokers. These boilers are operated in units of two, alternating with the third boiler. The boiler feed pumps consist of two 6x4x6 Cameron Horizontal Steam Pumps and a 10x6½x12 Cameron Vertical Marine Boiler Feed Pump, which are also used alternately, and in addition there is a 6x8x12 Cameron Wet Vacuum Pump. A Cochrane Open Heater is also installed in the boiler room.

Water for power plant and general purposes is piped in from a lake situated just above the plant. Condensed steam is reconveyed to this lake and provision for cooling and salvage made by means of spray nozzles. At the lake is located a 12" Vertical Motor Driven Cameron Double Suction Volute Centrifugal Submerged Pump with a capacity of 4,000 gallons per minute. Figure 17 shows the interior of the power house and Fig. 18 the cooling apparatus at the lake.

In this connection it is fitting that a word or two be said about the line of Cameron Pumps. As already intimated, these pumps find their application in numerous fields, a few of the more prominent installations being illustrated and described in the accompanying half tones and their captions. They range in size from a small boiler feeder weighing 135 lbs., with a daily capacity of 11,000 gallons, to large compound and twin pumps weighing 22,000 lbs. each and having a daily capacity of over four million gallons. In addition to the usual industrial installations may be mentioned the pumping equipments of the five large municipal ferry-boats built by the City of New York, as well as the armored cruisers North Carolina and Montana.

Quite recently the Cameron Steam Pump Works was awarded the contract for a large number of centrifugal pumps for the Panama Canal. These pumps are of the direct-connected to motor, centrifugal type and are used in connection with the hydraulically operated lock machinery, forming a part of the drainage and sump systems of the locks and gates.

Nine were of the 6" Vertical Volute Type for sump drainage, having a normal capacity each of 800 gallons per minute.

Three were 8" vertical Double Volute Pumps, for use in the main culvert, each with a nominal capacity of 4,200 gallons per minute. They were installed to pump the culvert dry, when occasion arose, and to take care of such leakage as occurs from the cylindrical valves and the bulkheads.

Forty-eight pumps on this contract were 5", Two Stage, Turbine Pumps, used in connection with a chain fender, for the protection of certain lock gates. Each of these pumps has a nominal capacity of 1,200 gallons per minute.

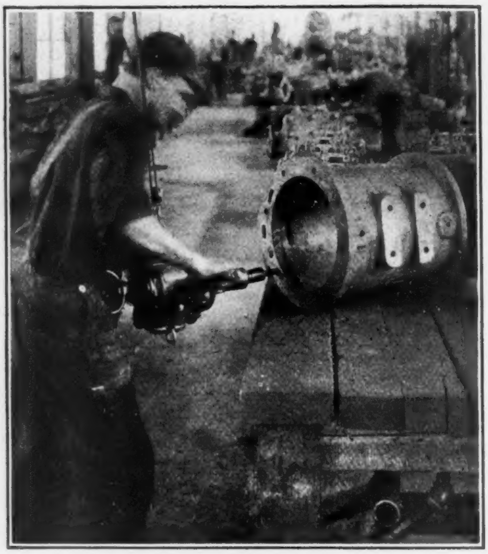


FIG. 7. INSERTING STUDS.

The specifications accompanying the call for bids on this equipment were very stringent and took into consideration the design, conditions and climate under which the equipment would operate, as well as such features as proportions and shapes of the water passages, impellers, vanes, outlets and bearings. The order was secured only after keen competition.

The Cameron line of Centrifugal Pumps is built in the Double Suction Volute type, up to 16 inches discharge, giving capacities up to 7,500 gallons per minute, and in the Turbine type, up to 6 inches, four-stage, ranging in capacities up to 1,200 gallons and to 800 feet head. They are also built in the Single Suction Volute type.

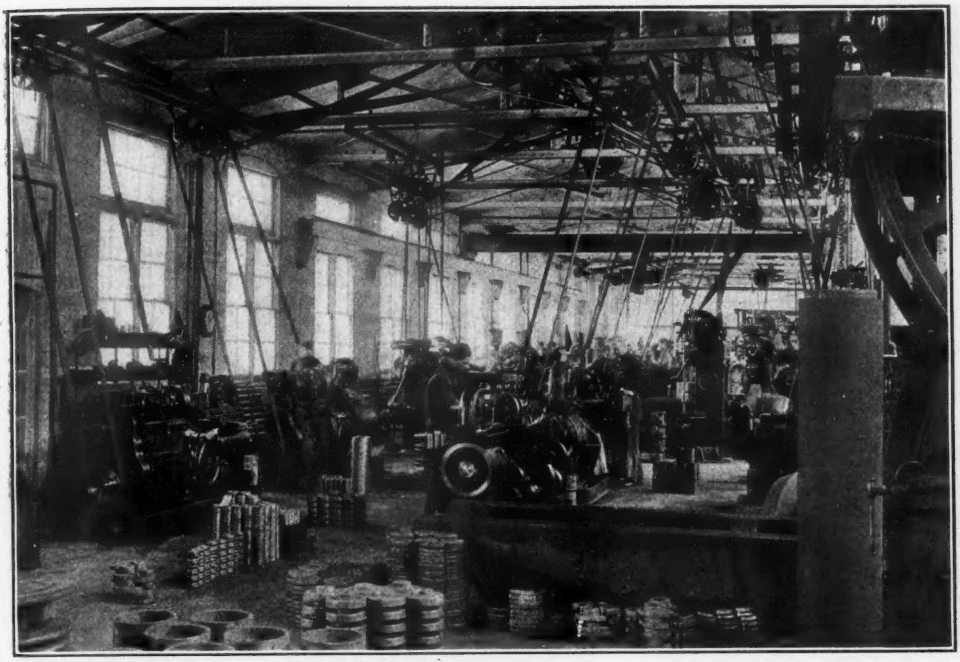


FIG. 8. SEMI-AUTOMATIC MACHINE TOOL DEPARTMENT.

METALLLIC POWDERS INCREASING THE POWER OF EXPLOSIVES

A U. S. patent—No. 1,054,777—has recently been granted to Roberto Imperiati, of Brescin, Italy, for increasing the power of an explosive by the addition in a powdered form of such metal as aluminum or silicon, their oxydation during the explosion causing an enormous increase of heat. When tungsten is alloyed with aluminum, the thermal energy of oxidation is increased and the aluminum is rendered more resistant to the action of oxidizing salts. Tungsten may be alloyed with both aluminum and silicon and a still more advantageous result obtained, or the tungsten silicide can be used. These mixtures or alloys reduced to powder before mixing increase the power of any explosive to which they are added, due to their great heat of oxidation. They can be added to explosive mixtures or to nitrated explosives, or can be used alone with a suitable oxidizing agent, such as ammonium nitrate. Such an explosive mixture can be made by drying and grinding the nitrate of ammonia and mixing in the alloy of aluminum, silicon and tungsten until the powder is substantially homogeneous. It is then dried and packed in cartridges. Combinations containing 65 to 85 parts, by weight, of ammonium nitrate and 35 to 15 parts of the metal mixture, may be used.

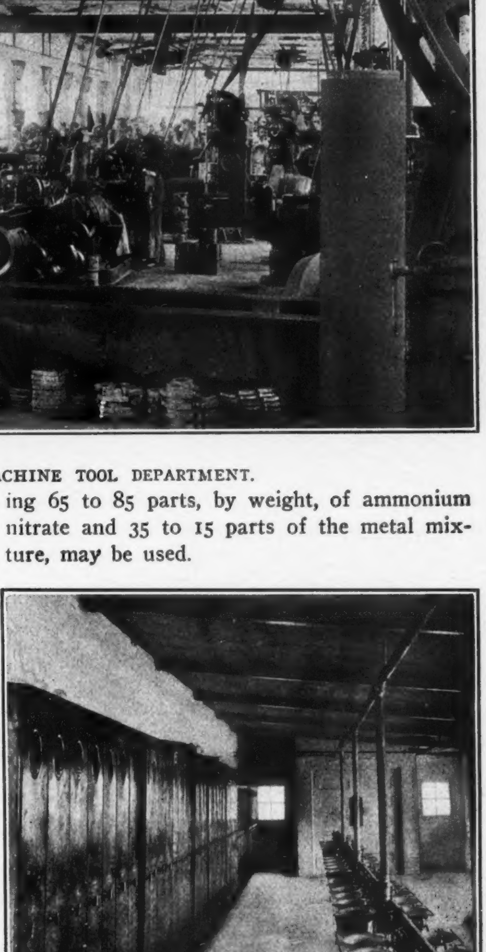


FIG. 9. WASH ROOM AND LOCKERS.

PRESSURES IN HOT RIVETING

When the yoke type of riveter is employed to upset and head a hot rivet at a single squeeze the pressure exerted is accurately indicated by the springing apart of the jaws. This has been taken advantage of for measuring and recording the various pressures required for rivets of different sizes, and at different temperatures, and is the subject of an interesting paper by E. D. Hays and W. L. Edwards in the March issue of the *Technic* of Rose Polytechnic Institute.

The deflections of the jaws of the riveting machine were magnified eight times by a pantagraph with a pencil tracing a record upon the drum of a steam engine indicator. The pantagraph was calibrated to determine the tensile displacement corresponding to a given force in the dies, and the result was plotted on cross-section paper, with the actual pressures as abscissæ and the tensile displacements as ordinates, the result being a line with a very slight upward curve.

A 26-in. portable bridge-riveting machine with toggle-driven dies was suspended with the axis of the dies vertical and in such a position that the heads of the Rhiele testing machine were between the die holders and transmitted their stress to them through conical bearings calculated to insure alignment.

After calibration the riveting machine was removed from the testing machine and suspended in a similar position during the remainder of the experiment. Another series of tests was made to determine the difference between the actual and theoretical pressures at different points of the stroke, corresponding curves were plotted from the results, and an efficiency curve was laid out showing that the efficiency increased throughout the plunger stroke until the last, when the theoretical pressure becomes infinite and the efficiency becomes zero. The maximum efficiency obtained was 62 per cent., which it was thought may have been partly due to the newness of the machine.

The rivets were driven through several thicknesses of steel plates clamped together and drilled 1-16 in. larger than the diameter of the cold rivet. They were heated in a portable forge with a hand blower to temperatures varying from 1,100 to 2,700 deg. Fahr., as determined by a pyrometer embedded in the fire close to the rivet, the latter being kept there long enough to acquire the temperature of the fire. It was believed that the drop in temperature between the forge and the riveting machine did not exceed 200 deg.

FIG. 10. SPECIAL JIG ON BORING MILL.

All of the rivets were of standarad lengths and had enough material to furnish a little excess steel in the head. The grips of the rivets varied from ⅝ to 1⅞ in. The shortest ones filled the holes completely, which was not the case with some of the longest ones. No loose rivets were found, and when some of the rivets were sawed through it was noticed that the very hot rivets had not filled the holes any better than some of the coldest ones. It was noted that the pressure did not increase in any large ratio as the plate thickness increased.

The lowest pressures, which caused many to completely fill the holes where the rivets gripped two plates whose combined thickness was about equal to the diameter of the rivets, were about as follows: For 1-in. rivets, 82,000 lb.;

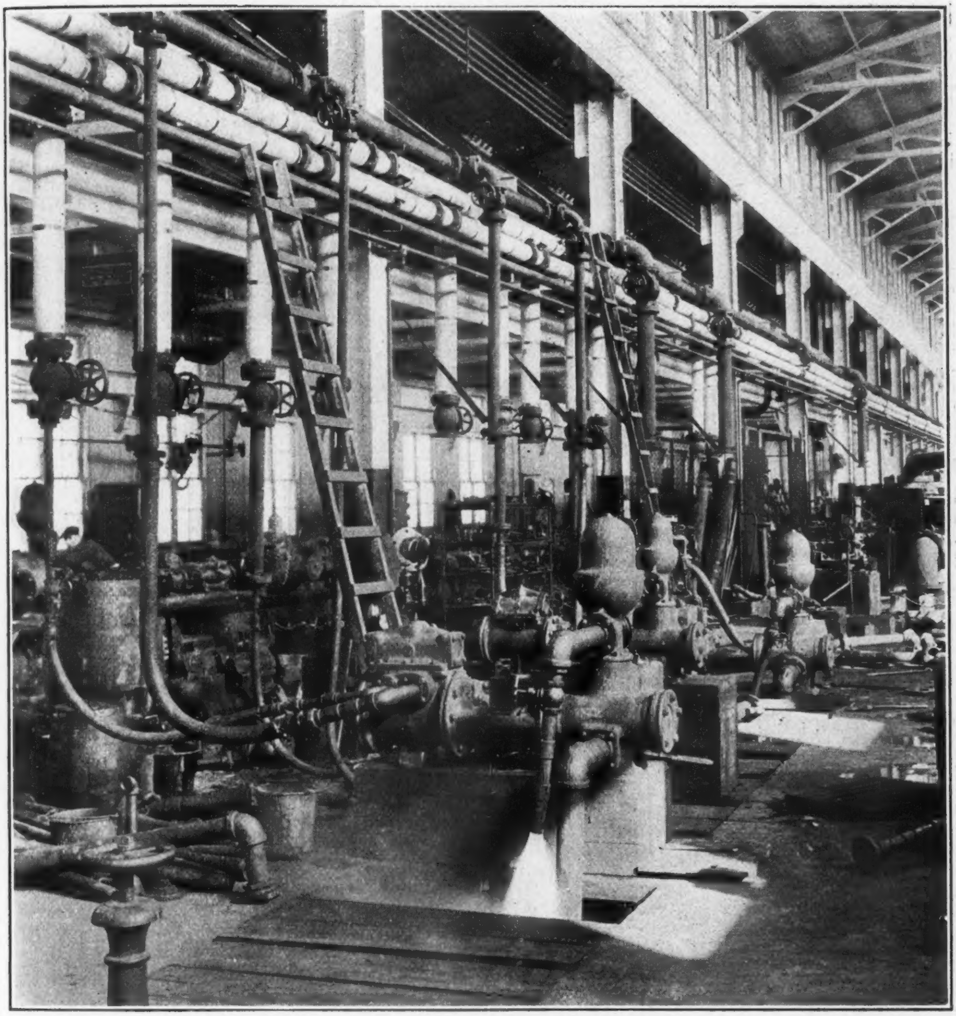


FIG. II. STEAM PUMP TESTING DEPARTMENT.

⅞-in. rivets, 70,000 lb.; ¾-in. rivets, 60,000 lb.; ⅝-in. rivets, 35,000 lb.

Of the 53 rivets driven, fourteen ⅝-in. rivets were driven at an average temperature of 1,914 deg. and an average pressure of 65,357 lb., and in an average time of 11 seconds each. Seventeen ¾-in. rivets were driven at an average temperature of 1,935 deg., 58,823 lb. pressure and 8 seconds time; fifteen ¾-in. rivets at 2,120 deg. temperature, 74,600 lb. pressure, and 11.7 seconds time; three 1-in. rivets, 2,400 deg. temperature, 53,000 lb. pressure and 20 seconds time; four ⅝-in rivets at an average pressure of 53,500 lb.

THE CORNISH MINER

BY P. B. MC DONALD.

The race that has done the most in the actual digging of ore in the mines of the United States is the Cornish. The Cornishman has not done much in the financing department, nor has he any letters after his name, but he has made a reputation for getting out the ore. In nearly all of the mining districts, Cornish miners and Cornish foremen are prominent. This is particularly true of the iron and copper ranges of the Lake Superior district, where he is an important factor. He

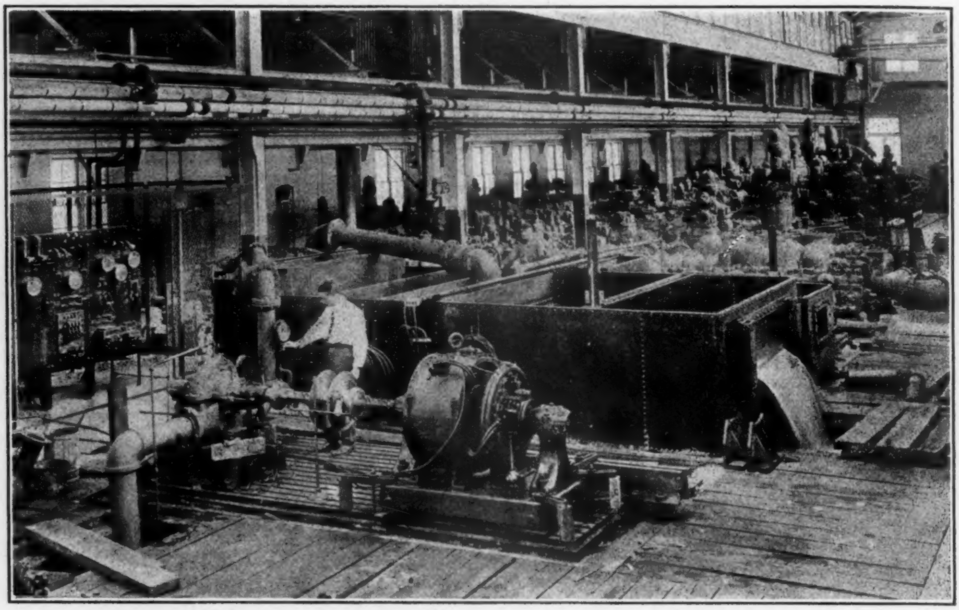


FIG. 12. CENTRIFUGAL PUMP TESTING SHOWING DYNAMOMETER.

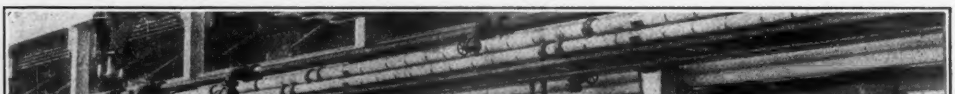


FIG. 13. REAR VIEW OF CENTRIFUGAL PUMP DYNAMOMETER TEST.

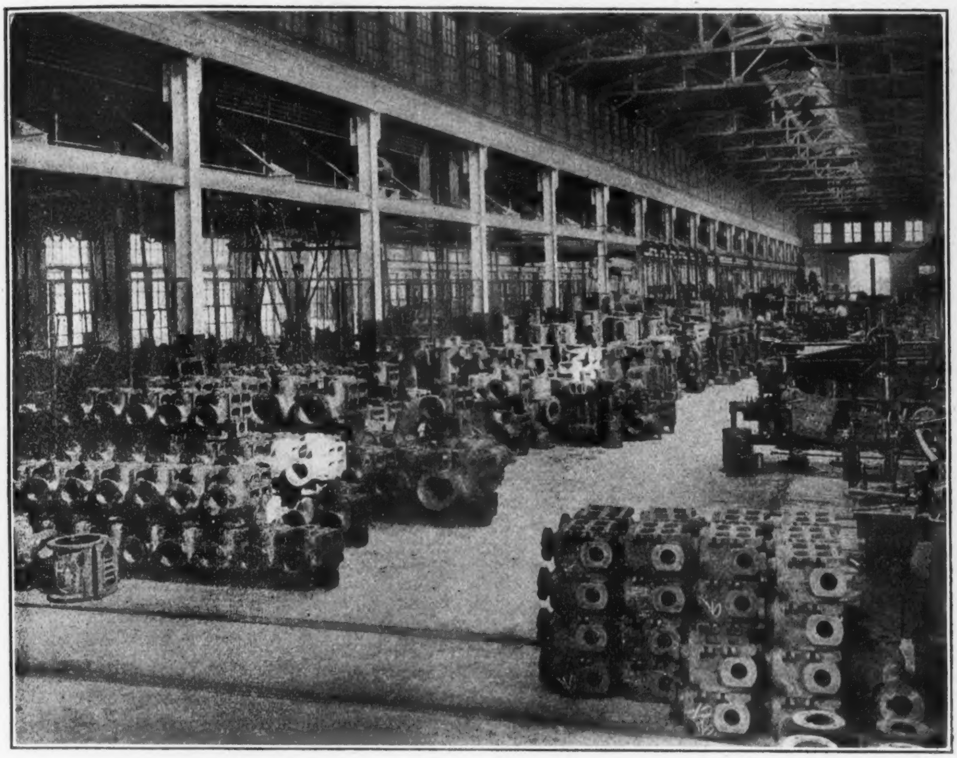


FIG. 15. SHOWING QUANTITY PRODUCTION.

is often to be found in the "Captain's" office, but in older mining communities will be found in nearly every capacity underground. You may catch him sitting and "smokin' 'is pipe," but at quitting time he will "'ave hout 'is hore." To a Cornishman a mine is a "hore-body" that must be "got hout" of the ground. To him the mine means a "West Hend" and

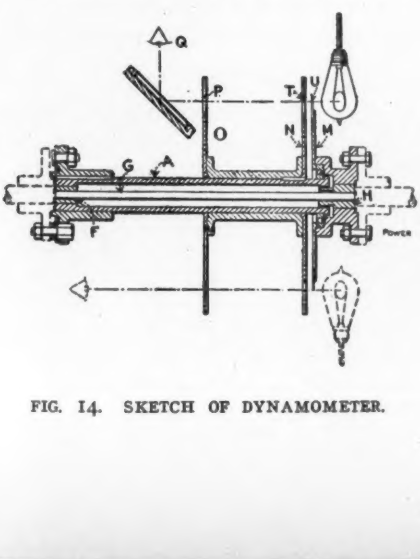


FIG. 14. SKETCH OF DYNAMOMETER.

a "Heast Hend," and the "Blue Stope," and the "'ard Hore Drift."

It is natural for the Cornishman to be a good miner, for very likely his father and grandfather worked in the mines of Cornwall. Sometimes the Cornish mining-captain and the mining-engineer don't get along well. This is because each arrives at his conclusions by an entirely different course. The engineer reasons things out, the Cornishman just "sees 'em."

Of course, with all his good points, the Cornishman has his faults. His aversion to shoveling is well known. At a small exploration near Iron River, two men were employed underground on each shift, and the day shift (composed of Swedes) threw all the shoveling possible on the night shift, while the night shift (composed of Cornishmen) did the same or a little better to the day shift. One night the Swede foreman, who was on surface, noticed that no dirt was coming up as there should have been; he jumped on the bucket and went down. The Cornish miner and help-

FIG. 16. IN THE FOUNDRY.

er were drilling merrily away, regardless of the pile of dirt that should have been shoveled into the bucket.

"Who in h—l gave you instructions to drill?" roared the foreman. The Cornishman, a first-rate miner, looked around, "Hi'm d—d sure hit wasn't Presdunt Roozevelt!" he answered.

In the community where the Cornishman lives, he takes great interest in local politics and likes to represent his section as alderman or supervisor. Many stories are told of elections in the old days, held perhaps in the schoolhouse, and of how, when the captain stood up, everybody else stood up. Another method much in vogue, was to vote by lining up on different sides of the room (where the captain could get a good look at each man); in outlying communities, this practice is still in use.

A Cornish miner who has worked a long time in a sucessful mine, will finally retire on a rocky little farm overlooking the scene of his former labors, and will live there happily in preference to moving into town. He likes to see daily the mine where he worked; if it is exhausted and closed down, he will tell you where he thinks the "hore" is, and will exhibit confident belief that the place will boom again some day. If the railroad has never been built there, he will predict its coming and will indicate the site where he thinks the station should be located, ending by declaring that he only hopes to live to see it.

Throughout the Lake Superior region he can be seen driving into town on a sunny day, or going in for a glass of "'arf-and-'arf," or sending "five poun'" to a nephew in the old country to help him come across. Whether he was a foreman or a miner, he enjoys being called "captain" and is always willing to stop and discuss "minin'."—*Eng. and Min. Journal.*

E. L. Hand, of Chicago, has just completed the invention of a cement gun which works like the older cement gun by compressed air, but the nozzle and mechanism is in no way similar to the old cement gun. Mr. Hand has worked the old gun, and observed the imperfections of that machine, particularly the vibratory motion, and the tendency of the materials to separate at the point of impact. He claims to have overcome the vibration objection entirely and to have reduced the waste of material to a very great extent.

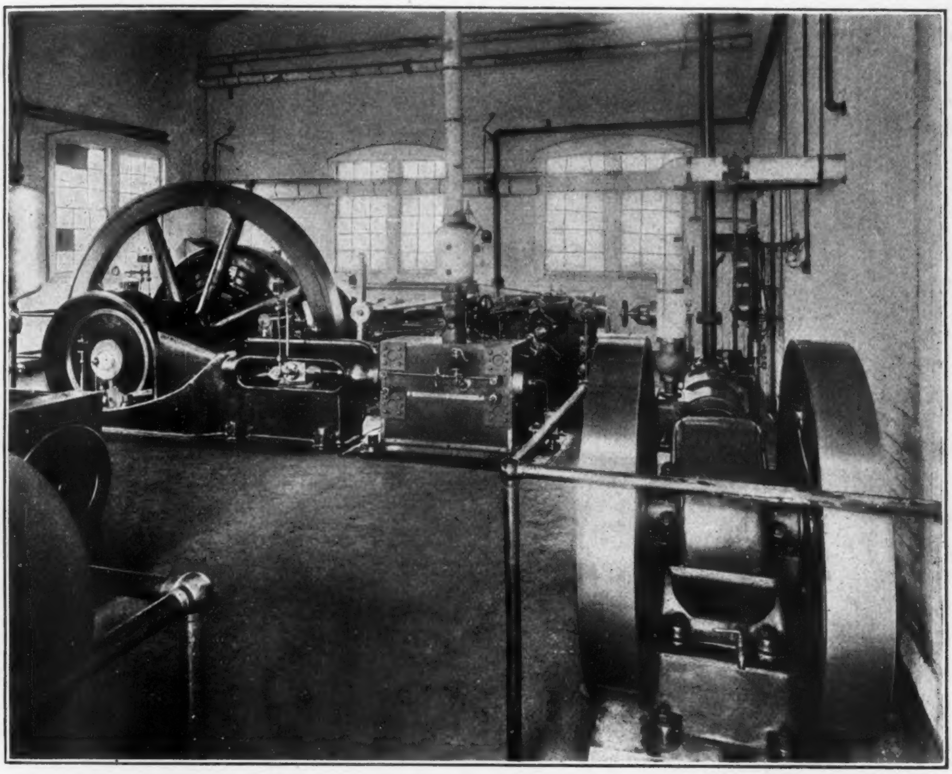


FIG. 17. IN THE POWER HOUSE.

BUREAU OF MINES PERMISSIBLE EXPLOSIVES

An explosive is called a permissible explosive when it is similar in all respects to the sample that passed certain tests by the United States Bureau of Mines, and when it is used in accordance with the conditions prescribed by this bureau.

But even the explosives that have passed those tests and are named in this list as permissible explosives are to be considered as permissible explosives only when used under the following conditions:

1. That the explosive is in all respects similar to the sample submitted by the manufacturer for test.

2. That detonators—preferably electric detonators—are used of not less efficiency than those prescribed, namely, those consisting by weight of 90 parts of mercury fulminate and 10

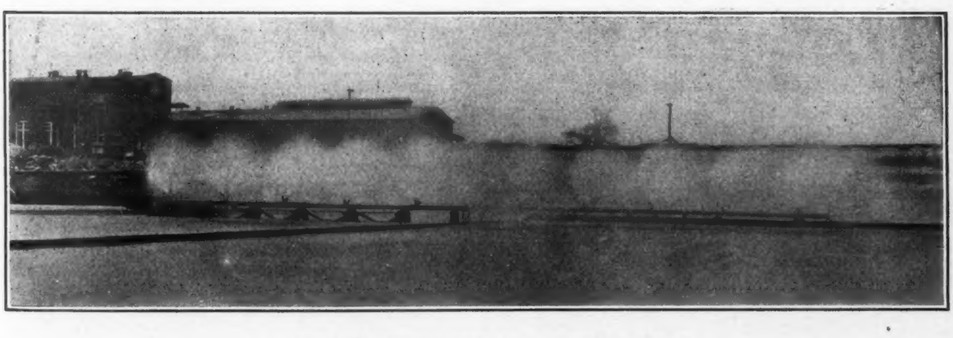
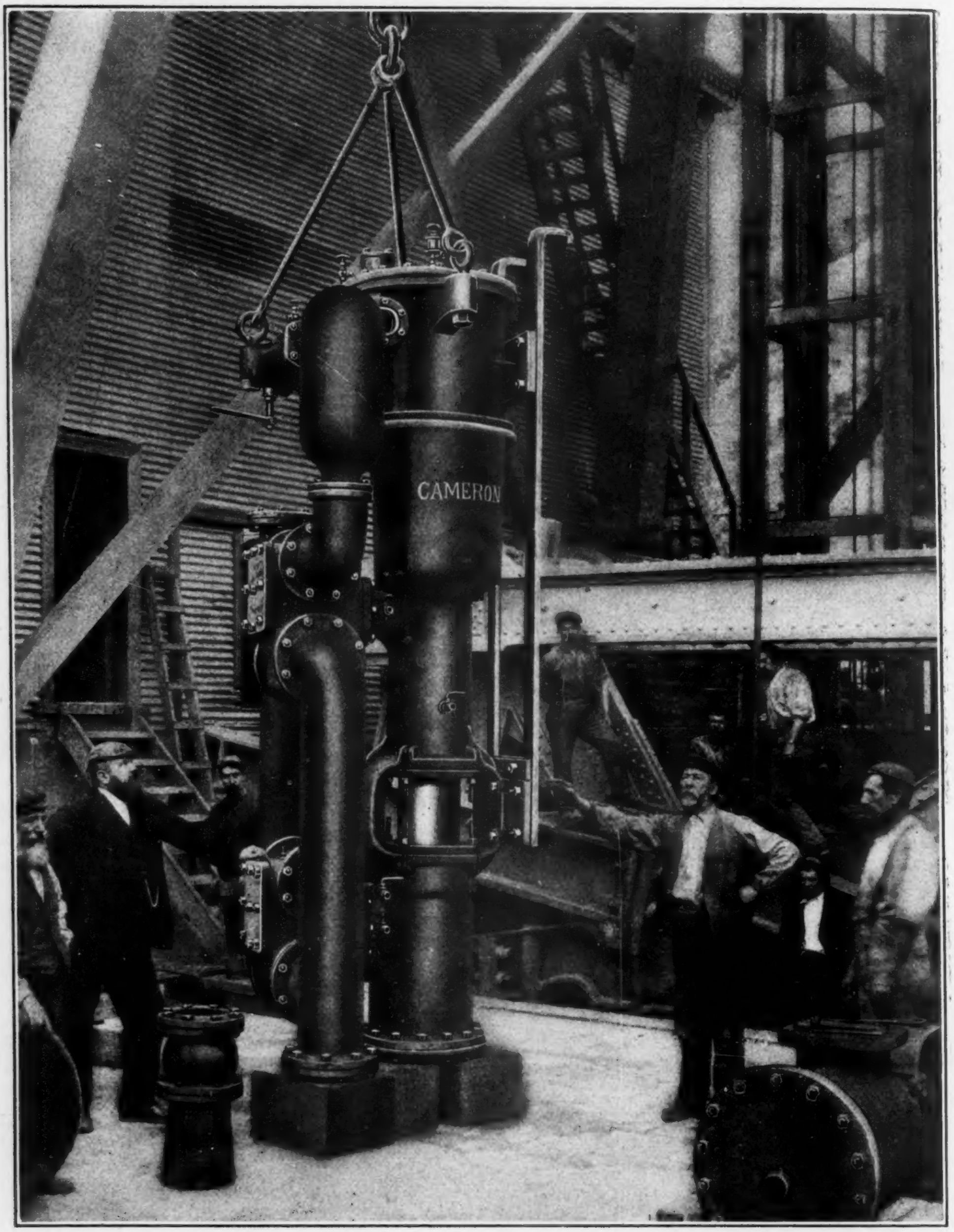


FIG. 18. THE LAKE AND WATER-COOLERS.



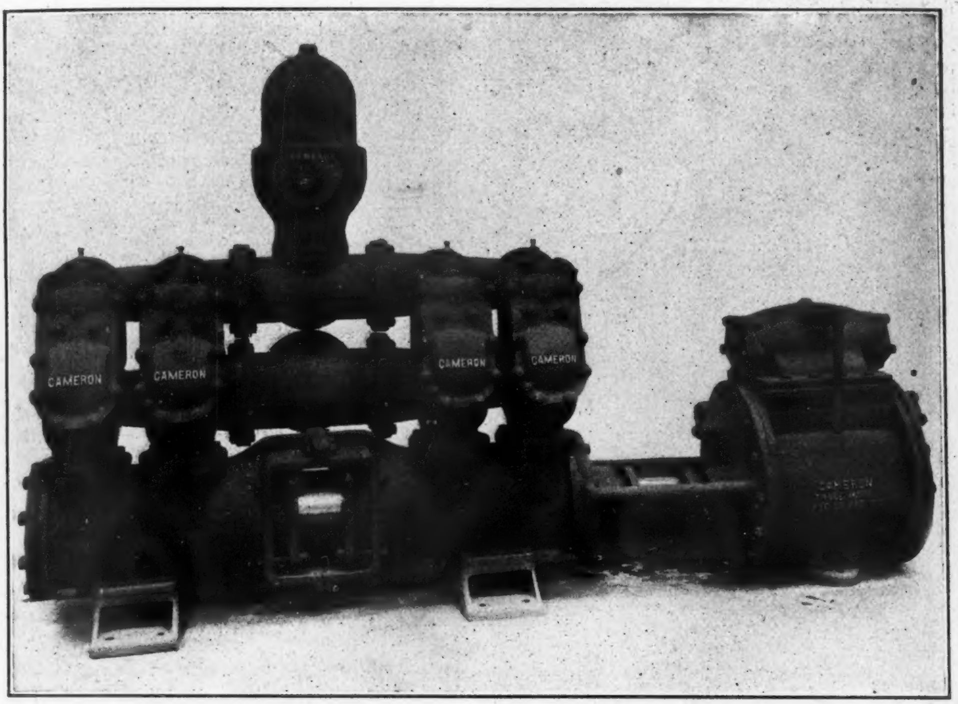
VERTICAL PLUNGER SINKING PUMP, AUKLAND, NEW ZEALAND.

parts of potassium chlorate (or their equivalents).

3. That the explosive, if frozen, shall be thoroughly thawed in a safe and suitable manner before use.

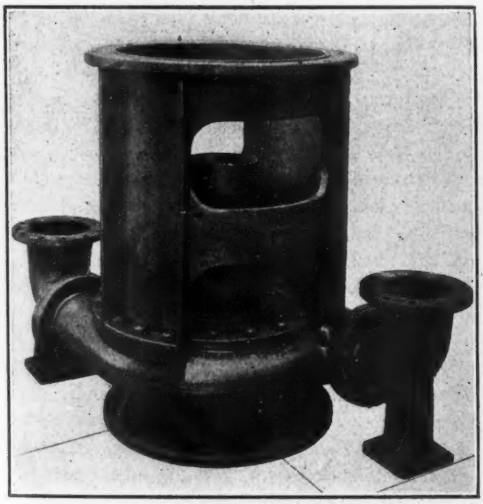
4. That the quantity used for a shot does not exceed $1\frac{1}{2}$ pounds (680 grams), and that it is properly tamped with clay or other non-combustible stemming.

It must not be supposed that an explosive that has once passed the required tests and has been published in lists of permissible explo-

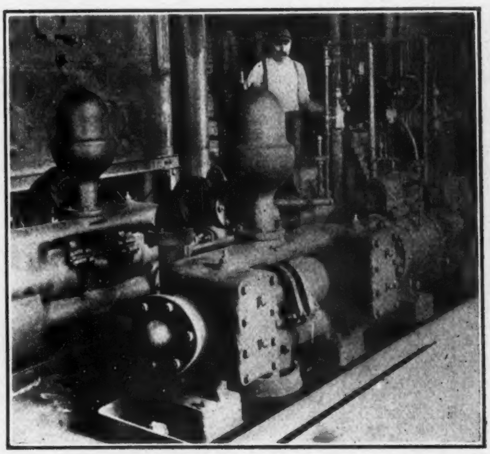


HORIZONTAL POT VALVE PLUNGER PUMP, CEMENT LINED.

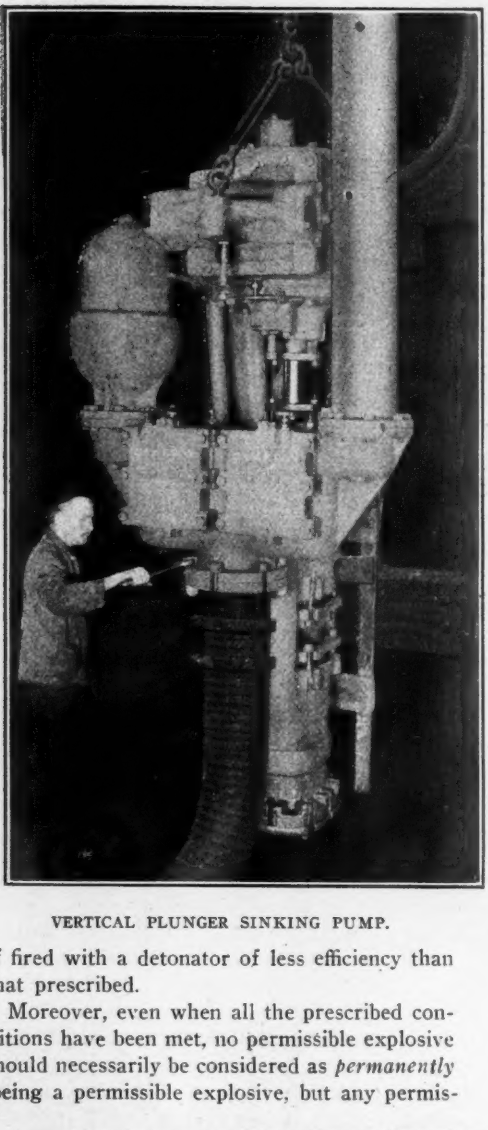
sives is always thereafter to be considered a permissible explosive, regardless of its condition or the way in which it is used. Thus, for example, an explosive named in the permissible list, if kept in a moist place until it undergoes a change in character, is no longer to be considered a permissible explosive. If used in a frozen or partly frozen condition, it is not when so used a permissible explosive. If used in excess of the quantity specified (1½ pounds), it is not, when so used, a permissible explosive. And when the other conditions have been met, it is not a permissible explosive



VERTICAL DOUBLE VOLUTE PUMP, PANAMA CANAL.



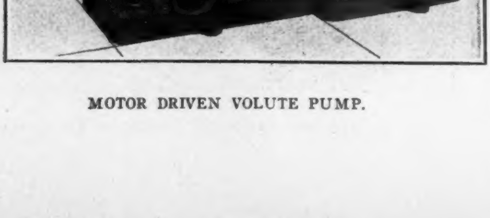
COMPOUND PLUNGER BOILER FEED PUMPS.



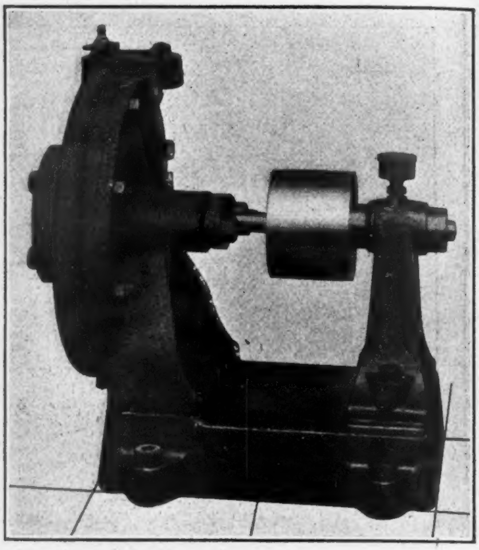
VERTICAL PLUNGER SINKING PUMP.

if fired with a detonator of less efficiency than that prescribed.

Moreover, even when all the prescribed conditions have been met, no permissible explosive should necessarily be considered as *permanently* being a permissible explosive, but any permissible explosive when used under the prescribed conditions may properly continue to be considered a permissible explosive until notice of its withdrawal or removable from the list has been officially published, or until its name is omitted from a later list published by the Bureau of Mines.



MOTOR DRIVEN VOLUTE PUMP.



SINGLE SUCTION VOLUTE PUMP.

Liquid air, and more especially liquid oxygen, are being experimented on in Germany as mine explosives, according to *Echo des Mines*. The latter, mixed with aluminum powder, and detonated, forms an explosive about 2½ times as powerful as black powder, from which there can be no deleterious fumes, as the only products of an explosion are oxygen and alumina.

For four years the town of Ocos, in Guatemala, enjoyed the benefits of electric lighting, but now it has reverted to oil lamps, as its power-house has gone to sea! It appears that a vessel of the Cosmos Line was driven into the shallows near the town by a large wave, and remained imprisoned in the lagoon, but without being damaged. Some enterprising person thereupon used the dynamos on board for lighting the whole town by electricity. The scheme was a great success, until a still more enterprising man came along who undertook to extricate the ship from its awkward position, and succeeded. The leads were cut, the vessel went back to sea, and the inhabitants of Ocos went back to oil lights.

AIR LIFT PUMPING AT HOUSTON

A recent report of J. B. Williams, superintendent of the water department at Houston, Texas, gives interesting information concerning the water supply. The city is using about forty wells and all of them are now operated by air lifts.

The first wells were sunk in 1888, and by 1899, 31 wells had been sunk, all used without the air lift. In that year, 13 of the wells were piped with air, and the others were modified in the same way in succeeding years, practically all of those drilled since 1899 having been provided at the same time with air lifts.

In applying the air lift, the central water pipe was lowered to a depth of from 123 to 128 feet, except in one case where it reached 183 feet; while the air pipe was lowered to 120 feet in all but two cases where the depth was 2 feet greater. The central water pipe varied in diameter from 3⅜ inches to 8 inches, depending upon the size of the well. The air pipe varied from 1 inch to 2 inches, being 1¼ inches in most cases.

In about half of the wells sunk in 1899 and all of those since that time, no central water pipe was used, and the air pipe was increased to a diameter of 1¼ to 5 inches, the majority being 3, 3½ or 4 inches.

Before air was applied, these wells varied in discharge from 28,800 gallons per day to 724,800 gallons; while after the addition of air the flow of the former of these was increased to 159,840 gallons, and the flow of the latter to 1,123,200 gallons. Air was applied to the former in November, 1900, and about a year ago the well had ceased to flow altogether either with or without the use of the air lift. The latter well was finished in January, 1905, when it delivered 724,800 gallons. The air lift was added in January, 1907, which increased the flow to 1,123,200; but five years later, the flow without the air lift was found to be only 90,000 gallons, and with the air lift 985,000 gallons. The average of all of the wells supplied with air lifts was as follows: Natural flow before air was applied, 169,770 gallons; flow with air lift when first applied, 507,879 gallons; flow in January, 1912, without air, 57,257 gallons; flow in January, 1912, with air, 316,118 gallons.

It is seen by the above figures that when the wells were new, the use of the air lift increased the flow on the average nearly three times. At the time of the report the wells then in use averaged twelve years old, and the flow without air averaged a little over one-third as great as when the wells were first put into service, and about 54 per cent. as much water could be obtained by the air lift as was obtained when the air was first applied to the wells. Also it was found that the flow obtained by the air lift at the time of the report was about five and a half times as great as the flow without air at that time, 17 of the wells showing no flow whatever without the use of air.

A new method of removing hard scale from boilers is described in "Engineering." The apparatus (known as the "Pyro" boiler cleaning system) used consists of an oxy-acetylene blowpipe with two or three jets, a portable acetylene generator, a steel cylinder of compressed oxygen, and the necessary length of flexible tubing. When it is desired to remove any scale, the blowpipe flame is played upon it for a few minutes (depending upon the thickness of the scale) until the scale cracks and falls off due to rapid expansion under the high temperature. If the scale is slightly damp, the operation is assisted. Care should be taken to keep the flame from playing on the bare plate for any length of time.

Giving indication of appreciation of the thoughtlessness of motorists in general, one prominent manufacturer has taken to equipping his cars with an oil level indicator which short circuits the ignition current when the supply of lubricant drops below normal. It is nothing more complicated than a tube enclosing a float buoyed up by the oil. The float carries a contact which touches another contact when the float drops, thus short-circuiting the magneto and giving unmistakable indications of the scarcity of oil.

Experiments made to bring aluminum to a liquid condition so it may be spread when cold over any dry surface have, according to the German press, been crowned with success. The composition is applied like paint with a brush and looks, when spread, like a dull silver coating.

A PROBLEM IN MINING, WITH SOME DATA ON TUNNEL MINING

BY W. L. SAUNDERS.

[The following is in discussion of a paper with the above title by F. M. Simonds and E. Z. Burns, presented at the New York Meeting, Feb., 1913, of the American Institute of Mining Engineers].

Mr. Burns in his native Colorado modesty has said that he apologizes for things left out of this paper. I am much impressed by what he has put into the paper, as, of all the papers that I have read on the subject, describing, as it does, a specific piece of work that has been accomplished, I do not recall one that gives so much information in such a practical way. Mr. Burns has said that it is very hard to get men to put things down while the work is being driven. My experience is that it is very much harder to get the men in charge of work of this kind to bring them in in the form of a report before a body of engineers after the work is done. We have a great many cases where records are kept in much detail, but they are usually kept under cover, with the mistaken idea that the information gained is private information for the benefit of those who have done the work. Messrs. Simonds and Burns have opened up this case so that we can get the benefit of that experience which they have had, and so that we can learn something for the future.

The description contained in this paper, as I have said, is a very practical one. You will notice in going through it that the authors have given in detail a record of their work from the beginning to the end, and they even go so far as to publish an exact copy of the Rawley Mining Co.'s daily report. That daily report is something which those of us who are engaged in similar work might copy to great advantage, and having it before us we can check up our men while doing work and exact from them equal conditions, if it is possible to do so.

The dimensions of this tunnel are 7 ft. high by 8 ft. wide, with a length of a little over 6,000 ft., so you see we have here a typical mining tunnel, a little over one mile long, and with the usual dimensions of 7 by 8 ft. The best monthly progress, firing from 8- to 12-ft. rounds, was 414 ft., and the best monthly progress for the shallow rounds, from 4.5 to 5.5 ft., amounted to 555 ft. I want to call particular attention to that statement, and those of you who have read the paper will see that when they changed from a double shift to a triple shift, putting in shallow holes, they got better progress. The shallow hole idea is the European idea, it is the Alpine tunnel idea, it is the idea by which engineers have carried through those great enterprises of piercing the Alps, in the case of the Simplon tunnel and the Arlberg and the Loetschberg tunnels. These recent tunnels which have been put through the Alps have all been driven on the shallow hole plan; in other words, a hole is put in about a meter or a little more than a meter in depth, and of rather large diameter, as compared with the American system, which is, a hole as large as you can reasonably get it, and that means, by the time it is in to the bottom, say 10, 12, or 14 ft., it is just a little larger than the diameter of the steel, the result being that you are putting the explosive at the bottom in a section of hole of small diameter, which is the very reverse of what is wanted in order to produce the most effective results. It is much better—and this is a point that I have emphasized before the Institute in papers in the past years—to put in a large number of shallow holes of large diameter and use a great deal of powder than to put in a small number of deep holes and try to save powder and try to be very particular about the exact direction that the hole must take. The European system simply peppers the head with holes, and better results are obtained by that method.

The total cost per foot of advance in the completed tunnel was $19.87. That is a very fair figure, and less than the estimate of cost made before this tunnel was driven. The average total cost per cubic yard excavated was $7.64. That may seem high to some of us, but if you go over the figures of labor cost in this paper you will see that the wages are higher. The people employed on this work evidently were compelled to pay a maximum rate of wages for this class of work, and, taking that into consideration, the figures are not high. The average number of feet of hole per drill per drill-hour was 12.2. The average inches per drill per minute was 2.5. The approximate yardage per foot of advance, allowing for 25 per cent. of overbreakage and swelling, was 2.6 yards, or a cost of $7.64 per cubic yard. In all of this we must take into consideration the

difficult rock which was encountered and the water troubles which they had; yet, comparing the progress of this tunnel with that of any of the recent tunnels of which we have records, the progress appears to be very favorable. The most recent of these records was made at the Arizona Copper Co.'s mines at Morenci, Ariz., the tunnel being 8 by 9 ft., where 780 ft. advance was made in 29 days, employing two C-110 drills mounted upon a cross-bar. We also have the record of the Laramie tunnel, in Colorado, which is similar to this one except that it has a ragged section. It is nothing but a hole, without any specified dimensions of outline, but it serves its purpose very well as a drainage tunnel. Being ragged, it enabled progress to be made in excess of that given in this paper.

Now, the description of the process of driving tells us that this tunnel was driven by the system of mounting the drills on a horizontal cross-bar across the tunnel. Here we have a thoroughly modern system; the same, by the way, as was used at the Laramie tunnel. In the American system of tunnel-drivng vertical columns with arms on them are usually employed. The European system of tunnel-driving is one in which horizontal bars mounted on carriages are employed. The system described in this paper is neither one nor the other, but the drillers used a horizontal bar without any carriage; in other words, they adopted the Alpine system ot tunnel-driving, but did away with the carriage. Now, they were able to do away with the carriage because they used hammer drills instead of piston drills in the headings. The piston drill is a machine which reciprocates and which creates a great deal of shock on its mounting, necessitating a very heavy bar or column. The machine itself is heavy, and necessitates the use of either the carriage system or the vertical column with arms.

It appears that those who drove this tunnel used the hammer drill, which is lighter in weight and does not give the jarring and reciprocation, hence they were able to use a light bar, which a few men in the heading can handle to advantage. This light bar is carried on top of the muck pile after the blast and jacked in place close to the roof; the drills are put on and put in operation; the men work the drills standing on top of the muck, the muckers being at work at the same time in digging away the muck underneath them. By the time the muck is largely removed the drillers are about ready to let the bar down, and just about that time the muck has been taken away, so that if necessary the bar can be placed in a lower position in order to put in the lower round of holes, if these cannot be drilled from a single setting of the cross-bar. By such a system as this they were able to make a progress, I believe, of 26 ft. per day; in other words, a little more than 1 ft. an hour during all of the 24 hours in the day. That, of course, is not the record. The Alpine system has made about 30 ft. per day, and in the Laramine tunnel they made something like 24 ft. a day. Comparing progress of this character, however, we must always take the character of the rock into consideration; also the length of the tunnel. The Alpine tunnels are longer tunnels, and, by adopting a certain system and carrying it out for a long period of time, it was possible to get the efficiency of the workers very high.

The engineers in this tunnel decided that better results could be obtained by drilling shallow holes and operating three shifts per day. This plan was put into effect in December, 1911, and, as I understand from reading the paper, it proved to be very efficient. The results, as given in the table printed in the paper, show that the average number of feet of hole per drill per drilling hour was 12.2. This is good, but not remarkable, as it involves only approximately 2.5 in. per min. Of course, the rock conditions govern this. On page 393 reference is made to the results obtained in the entire equipment of the tunnel.

This subject is one which is very active at the present time, because American engineers are adopting a system of tunnel-driving which is to a certain extent a cross between the European and the old American system, but which has, I think, a great many points of advantage over both of them.

It is stated in *Consular Reports* that in all countries where shipbuilding is carried on the shipyards have been besieged with so many orders that at this time it is impossible to place an order for a new steamer which can be completed before 1915.

THE ACTUAL VALUE OF INTERCOOLING IN AIR COMPRESSION

BY R. S. HOWARD.

When guarantees of economic performance of any piece of power machinery are made, the guaranteed results are always stated to be reached under certain definite and specified conditions. For instance, steam engine economy is stated with a certain steam pressure at the throttle, a certain vacuum at the exhaust, a certain load and a certain speed.

For air compressing machinery the air end is guaranteed to deliver a certain quantity of air against a certain discharge pressure at a certain speed, and measured at the temperature and pressure of the intake, the barometer reading being known. Also this is to be done with the horse power exerted not exceeding a certain figure, when *perfect* intercooling is attained.

This matter of intercooling the air between the stages of compression is of extreme importance, because the horse power is materially influenced by the degree of intercooling. The opportunity of intercooling is the one and only reason for multi-stage compression of air, and the benefits are twofold.

First, intercooling reduces the temperature of the partially compressed air before it enters the next cylinder, and thus reduces the final temperature of discharge of this next stage. The compression of air from atmospheric to 100 lb. gage pressure, starting from 60 deg. F., results in a final temperature not far from 480 to 500 deg. When air is compressed to such a temperature as this there is danger of the carbonizing of the lubricating oil, and in large quantities, where the heat is not carried away, explosions of mixtures of air and oil are altogether too frequent.

If this work is done in two stages, with proper intercooling before entering the high pressure cylinder, the temperatures can be kept down to between 250 and 275 deg. The final temperature depends somewhat on the speed of the machine, as at high speeds the water jackets around the cylinder walls are not so effective as at slower speeds.

The other reason for stage compression and intercooling is to reduce the horse power required to compress the air. For instance, to compress 100 cu. ft. of air to 100 lb. gage pressure in one minute by single stage compression requires somewhat over 18 I. H. P. in the air cylinder, while if this is done in two stages of equal work, the horse power will be about 15.5. This reduction in temperature is due solely to the cooling of the air, and the attendant reduction of its volume before it enters the second stage cylinder.

In order to make the saving above mentioned, it is necessary that the air shall be intercooled back to the temperature at which it first entered the low pressure cylinder. This is described as "perfect intercooling." The other extreme is no intercooling at all, which amounts to plain, single stage compression, irrespective of whether it was done in one cylinder or two. Between these two extremes lies the middle ground of partial intercooling, which is the condition most often met in practice. The degree of intercooling depends upon the area of the intercooler surface and the amount and temperature of the cooling water. The relative area of the cooling surface depends upon the quality of the machine; the finer the grade of machine purchased, presumably the greater the cooling area per cubic foot of air compressed. Modern practice has greatly increased the cooling surface provided. The quantity and temperature of the cooling water are largely local matters, and are sometimes beyond control.

This last puts the air compressor performance somewhat at the mercy of local conditions, especially the weather. For suppose the intake air is at, say 20 deg. F. and the cooling water is at 35 deg.; obviously no amount of cooling water will produce "perfect cooling," no matter how much cooling surface is provided in the compressor. In fact, with present day coolers of usual design, the temperature of the air leaving the intercooler can scarcely be colder than 20 deg. *above* the temperature of the incoming water. Thus, with 60 deg. atmosphere, 40 deg. cooling water, and plenty of it, with adequate surface, the air would leave a properly designed intercooler at 60 deg. and there would be a condition of "perfect" intercooling.

Because such a thing is commercially possible, and is a standard base upon which to figure, air compressor builders always specify "perfect intercooling" when guaranteeing horse power requirements. The fact that local conditions so often limit the possibility of intercooling, renders it necessary in almost all cases of economy tests of air compressors to make

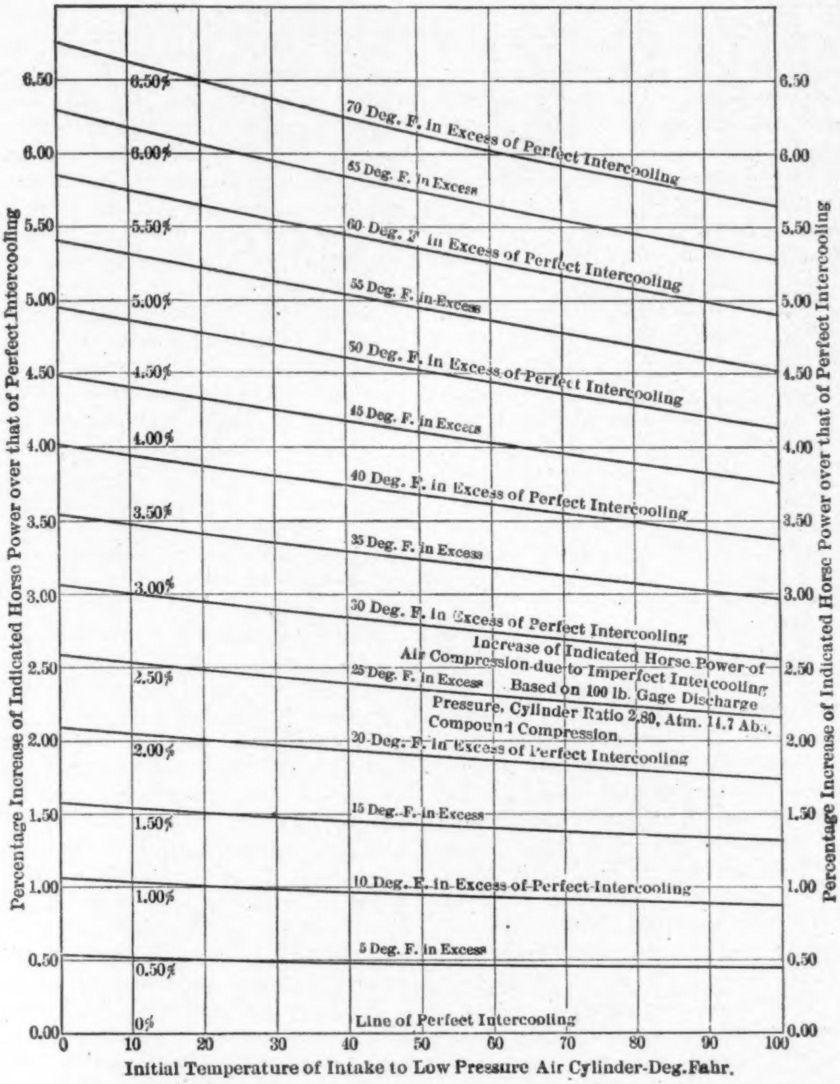


FIG. 1—INCREASE OF INDICATED HORSEPOWER OF AIR COMPRESSION WITH PARTIAL INTERCOOLING

a correction of the test figures for the actual cooling attained, in order to compare the results with the guaranteed figures. This process is not an easy one, and where there are several tests to figure, it becomes laborious and tedious, as well as a great consumer of valuable time.

This state of affairs is due to the apparently curious fact that, while with perfect intercooling the total horse power of an air compressor is not affected by the temperature of the air it takes in, with imperfect intercooling the horse power is affected by the temperature of the intake air. Thus, with perfect intercooling, the horse power of the air cylinders will be the same, no matter whether the air received is at 20 deg. or 60 deg. or 120 deg. or any other temperature, always assuming that the air entering the second stage is cooled back to the same temperature as that

entering the first-stage cylinder. However, if the intercooling is, say, 35 deg. short of perfect, so that if the fresh air is at 20 deg. F. and that entering the second stage is at 55 deg. F., the horsepower will be increased 3.42 per cent.; whereas, if the initial temperature is 80 deg. F. and the intercooling is only to 115 deg. F., the increase in horse power over perfect cooling will be only 3.07 per cent. The reason for this is that the increase in horse power is a function of the absolute temperature ratios, and the higher the temperatures are, a given difference of temperature makes a smaller ratio; thus, 20 deg. F. is 481 deg. absolute, and 55 deg. F. is 516 deg. absolute, so that their ratio is 516÷481=1.072; while 80 deg. F.=541 absolute, 115=576 deg. abs., their ratio being 576÷541=1.064. The calculation is not nearly so easy as this, as it involves fractional exponents, and for acuracy requires the manipulation of at least five significant figures because of the small ratios involved.

Because the writer has had a great deal of this calculating to do, and because it is not only laborious and time-absorbing, but also difficult to perform accurately and consistently with a slide rule, by reason of the small ratios and fractional powers involved, the accompanying diagrams have been plotted. These give the percentage increase of indicated horse power with various degrees of cooling, from perfect up to a discrepancy of 70 deg., with intake temperatures from zero to 100 deg. F. at the entrance to the low-pressure cylinder. In diagram given in Fig. 1, horizontal distances represent initial temperatures at the entrance to the low-pressure cylinder, vertical distances represent the percentage increase of horse power over that required with perfect intercooling, and the diagonal lines represent various excesses of temperature over and above the temperature of the intake to the low-pressure cylinder. Thus, suppose the low-pressure intake is at 20 deg. F., and the high-pressure intake is at 55 deg. F.; then the "excess of temperature above perfect intercooling," as shown on the diagonal lines, would be 55 less 20, or 35 deg. F. If we enter the diagram at the line of 20 deg. low-pressure initial temperature and follow it up to where it intersects the diagonal line coresponding to "35 deg. excess," we find the increase of I. H. P. is 3.42 per cent., as previously stated. Also, as in our previous case, if the initial low-pressure temperature was 80 deg. F., and the temperature of the high-pressure intake was 115 deg. F., the excess of temperature of the high-pressure intake was 115 deg. F., the excess of temperature would again be 35 deg., and following the 80-deg. initial temperature line up to its intersection with the diagonal line of 35-deg. excess temperature, we find the increase of horse power is 3.07 per cent.

The diagonal lines for excess temperature appear to be almost straight. As a matter of fact, the bottom line of no excess temperature is straight, of course, but it will be found by trial with a straight-edge that the lines become more and more curved the greater the excess temperature. The calculations have been carried only to an excess of 70 deg. above perfect cooling, because excesses greater than this would seldom occur with modern designs, and certainly never would be allowed in any economy test.

For the practical use of the diagram in Fig. 1, let us suppose that the I. H. P. of a given compressor was found on test to be 432 ,and that when the test was made the low-pressure initial temperature was 33 deg. F., and the high-pressure initial temperature 75 deg. F. This gives us an "excess temperature" of 42 deg. with 33 deg. initial, which we will find from the diagram to give an increase of I. H. P. of 3.97 per cent. above that which would be developed if the temperature of the high-pressure intake also had been 33 deg. F., or a condition of perfect intercooling. If these temperature conditions cause an increase of I. H. P. of 3.97 per cent., the horse power which the compressor would have required with perfect intercooling would be found by dividing its actual horse power by 1.0397, or (432×100)÷103.97=415.5 I. H. P.

If the guaranteed figure had been "not to exceed 417 I. H. P.," the machine would have met the guarantee when the correction for intercooling was made, but would apparently have failed by 15 H. P. if no corrections were made. This illustrates the importance of such a correction as this and the great necessity of having it accurate, which, as said, is difficult with a slide rule. This and the fact that the results vary with every different intake temperature should make these curves of real practical value to all who have such work to do.

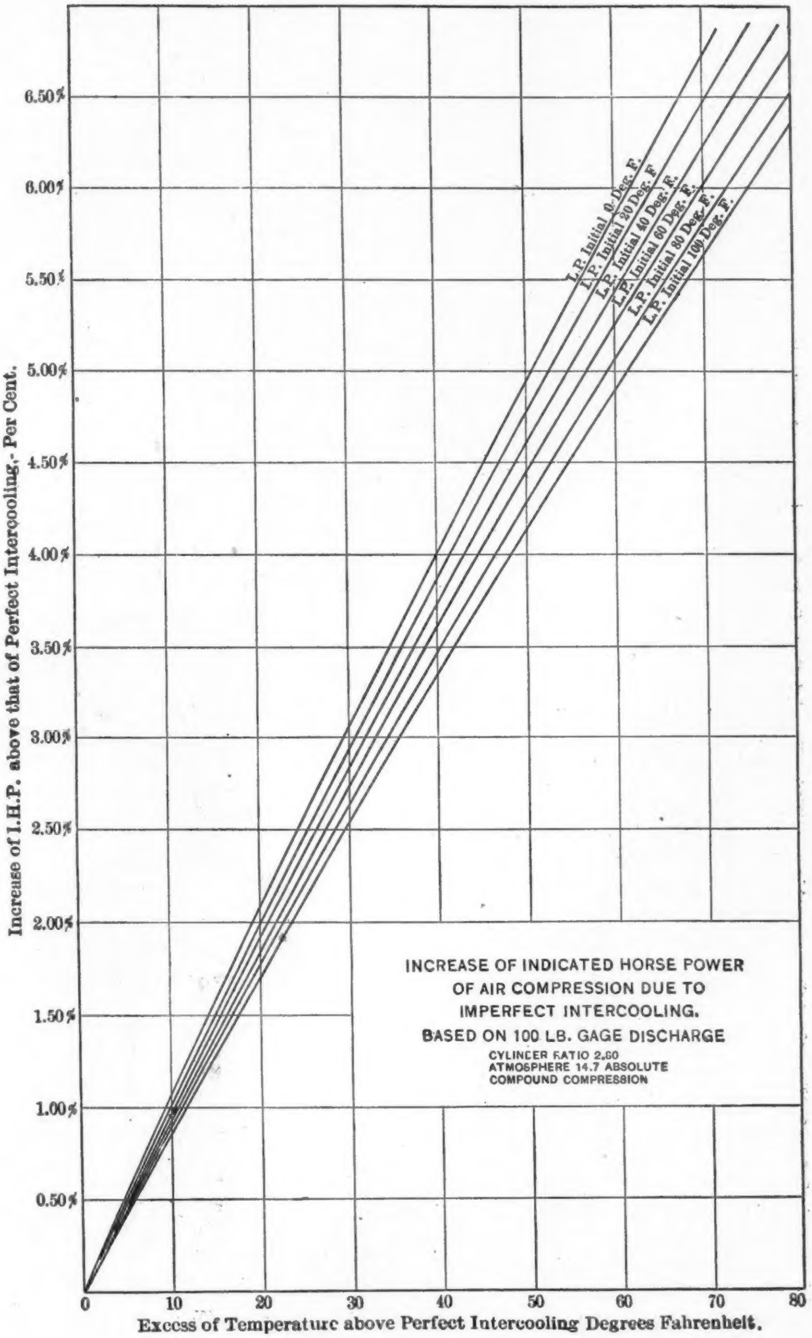


FIG. 2—INCREASE OF INDICATED HORSEPOWER OF AIR COMPRESSION DUE TO IMPERFECT INTERCOOLING

The curves have been plotted on an assumption of compression from atmospheric to 100 lb. gage pressure in two stages, and with a cylinder ratio of 2.8, giving practically equal work in the two stages of compression. If the test pressure is other than 100 lb., and is not more than a few pounds out of the way, it is customary to make the pressure correction to 100 lb., and this should be done before correcting for intercooling. If the effective cylinder ratio is not exactly 2.8 (as it seldom is because of the use of convenient cylinder dimensions) the actual horse power will be very slightly altered, but the *percentage increase* of horse power for that particular pair of cylinders over perfect intercooling with the same cylinders, will be practically indentical with the values given by the diagram.

As it is difficult to reproduce such diagrams on a magazine page to a sufficiently full scale, a condensed table of values is appended, from which it will be found easy to plot one's own curves to any desired scale. The values have all been obtained by longhand calculation, using never less than five significant figures and six places of logarithms.

CONDENSED TABLE SHOWING INCREASE OF I. H. P. OF AIR COMPRESSION DUE TO IMPERFECT INTERCOOLING.

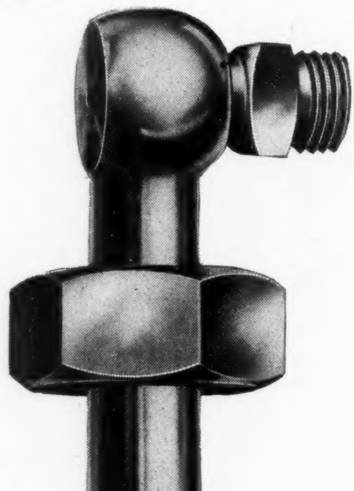
Compound compression from atmospheric to 100 lb. gage pressure. Cylinder ratio, 2.8.

Initial temp. of l.-p. cyl., Deg. F.	Excess of temp. above perfect cooling, Deg. F.	Temp. of air entering h-p. cyl. Deg. F.	Increase of total I. H. P. %
20	0	20	0.0
60	0	60	0.0
100	0	100	0.0
20	10	30	1.014
60	10	70	0.929
100	10	110	0.867
20	20	40	2.006
60	20	80	1.864
100	20	120	1.728
20	30	50	2.957
60	30	90	2.734
100	30	130	2.558
20	50	70	4.776
60	50	110	4.447
100	50	150	4.136
20	70	90	6.473
40	70	110	6.257
60	70	130	6.019
100	70	170	5.648

In this table only a few values are given, but by plotting these values, first as in Fig. 2 and then as in Fig. 1, all the intermediate points in each diagram may be plotted into the other diagram, finally arriving at such a set of curves as that shown in Fig. 1. In such a form it is possible to include all intermediate values because of its open construction; while Fig. 2, although giving to the eye perhaps a better mental picture of conditions than Fig. 1, does not admit of any more intermediate values without undue crowding.

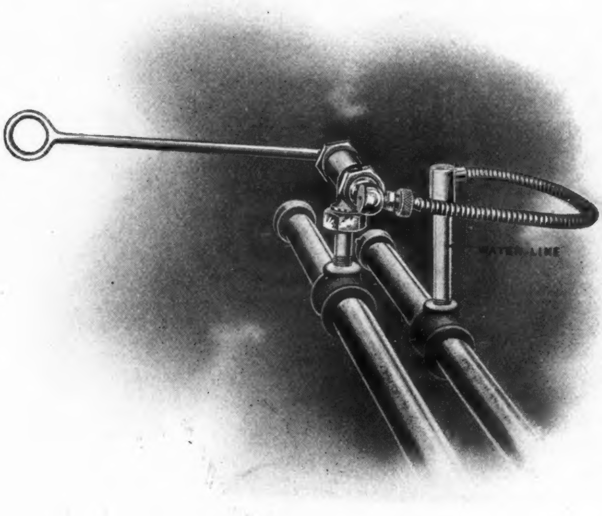
It is interesting to note that with no intercooling at all, the excess horse power is close to 18 per cent. At first thought it would seem that this percentage would vary with different low-pressure initial temperatures; but this means only that with different initial temperatures it requires a different number of degrees excess temperature to represent no intercooling at all, and these different excesses of temperature all correspond to about 18 per cent. excess horse power, and again corespond to the respective initial temperatures.

Another, visual, effect of defective intercooling is the raising of the intercooling pressure. This is due to the increase of volume of the warmer air entering the high-pressure cylinder, and it is this increase of pressure and increase of volume of air handled that increases the horse power.—*Industrial Engineering and Engineering Digest.*



THE TURBO-HUMIDIFIER

The desirability, and in fact in many cases the necessity, of controlling not only the temperature but also the humidity of the atmosphere in which industrial operations are to be carried on is coming more and more to be



THE TURBO-HUMIDIFIER AND CONNECTIONS.

recognized and provided for. Artificial heating of factories in winter, and, so far as possible, the cooling of them in summer is imperative; but it is quite desirable to control also the amount of moisture in the air, not only for the comfort and efficiency of the operatives, but also for the profitable manipulation of the materials of manufacture.

This is especially important in the textile industry, and it was quite in the natural order of things that an effective humidifying apparatus should have originated where the need of it was most urgent. The turbo-humidifier here illustrated is the invention of Mr. Albert W. Thompson, Mechanical Superintendent of the Amosking Manufacturing Company.

Fig. 1 shows the complete humidifier full size. The lower end is connected to the air pipe system, a suitable pressure being about 65 lb. gage, and the side branch to the water supply, the moisture laden air being discharged from a small hole in the center of the flat face opposite the water connection. It is not necessary to place the humidifier in a vertical position, as it works equally well however located.

The humidifiers are distributed about a large room or factory as judgment and experience may determine, Fig. 2 being a sketch of a typical mode of attachment. The handle at the left controls the water admission, and can be adjusted with great nicety according to the varying requirements.

This humidifier is a distinctly new departure in this line of apparatus. The objects sought in the invention were simplicity, efficiency, ease of adjustment and low installing and operating cost. The regulation may be at one point for a room or a group of rooms, or there may be individual regulation at each head. The chief aim was to secure complete vaporization of the water and in this respect there can be no comparison with the numerous class of atomizers or injectors.

The air, as was said, is delivered to the humidifier at a pressure of about 65 lb., while the water requires no pressure. The air passes through tangential passages surrounding a conical pointed hollow bushing through which the water emerges. The tangential jets of air produce a vacuum at the point of the bushing and also cause a rapid rotation of the water jet as it emerges, the centrifugal motion completely pulverizing the water and intimately mixing it with the air, the product as delivered being comparable with steam but without the heat.

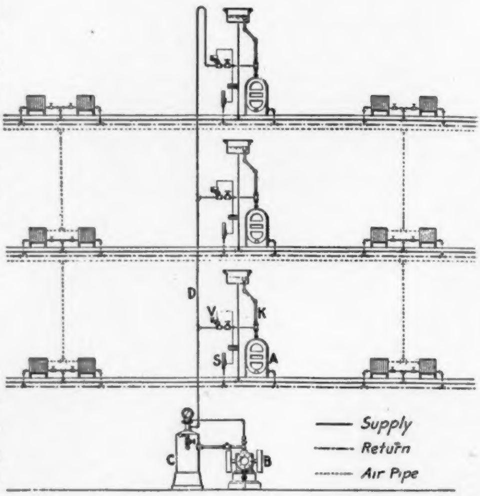
It is recommended that an independently driven air compressor be provided where this system is installed. This will permit complete humidification of the atmosphere before work

begins, and its proper maintenance at all times. The air pipes may be provided with tees or otherwise where connection can be made for taking off air for other purposes, and incidental uses for the air are almost sure to develop.

The apparatus is made by G. M. Parks Company, Fitchburg, Mass., who will supply more complete information concerning it upon application.

COMPRESSED AIR TO CIRCULATE HOT WATER

An illustration of the system designed by Herman Kraus, engineer of the German Museum in Munich, is shown herewith. The compressed air is introduced into a riser leading directly from the heater, or hot-water boiler to the expansion tank, where the air escapes and the water is returned through the radiators to the heaters. The supply of air may be controlled by the outside temperature or, as shown in the drawing, by the temperature of the return. A thermostat is connected with the return and controls a pressure-reducing valve on the air supply.



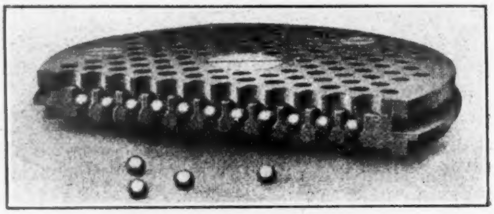
HOT WATER CIRCULATED BY COMPRESSED AIR.

The compressed air is supplied by an electrically-driven compressor which is automatically controlled according to the pressure in the air tank. From the tank, the air passes through the reducing valve and enters the riser through a specially designed nozzle.

In the sketch *A* represents the hot-water heater, *B* the air compressor, *C* the air tank, *D* the air-pressure piping, *V* the reducing valve, and *S* the thermostat. It may be noticed that an expansion tank *E*, and a hot-water heater are shown on each floor. From each expansion tank there is a connection to atmosphere so that air may escape without having the opportunity to enter the radiators and interfere with the operation.

In the state sanitarium at Hütteldorf, Vienna, ten large buildings are equipped with this system. The installations were made five years ago, and according to reports have given excellent satisfaction. Some of the advantages claimed by the inventor are adjustment of the rate of flow according to the outside temperature or to the temperature of the return, the possibility of obtaining the necessary amount of compressed air for a full day inside of one or two hours, central regulation, no possibility of overheating the water in the system and the use of pipes of small diameter.

Any hot-water heating system can be fitted up with the air equipment at small cost. The system is recommended especially for green houses where uniform and high temperature is essential.

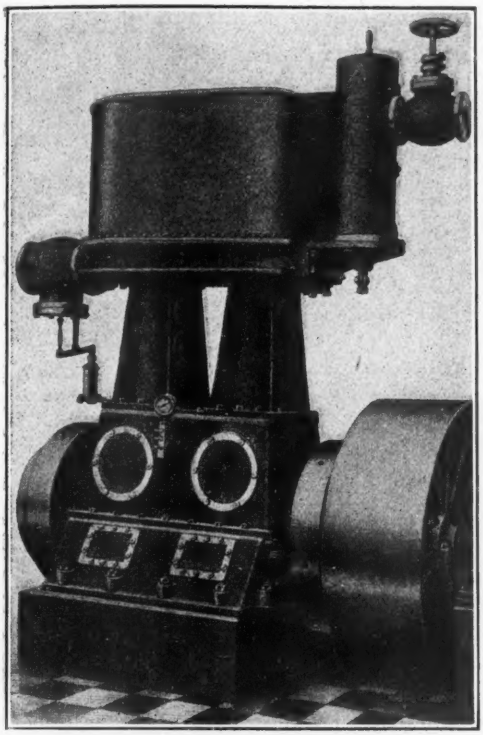


BALL VALVES IN CYLINDER HEAD.

AIR COMPRESSOR WITH BALL VALVES

The illustrations here reproduced from *The Engineer*, London, show the essential features of Scott air compressor, built by Isaac Storey and Sons, Limited, Manchester, England. The compressor here shown is a two stage, belt driven machine with single acting cylinders, which are entirely enclosed in a water tank which contains also the intercooler. The cylinders and tank are mounted on distance pieces, with a closed casing below which is utilized by a system of forced lubrication.

The special feature of this compressor is the ball valves, which are used both for the inlet, through the top of the piston, and for the



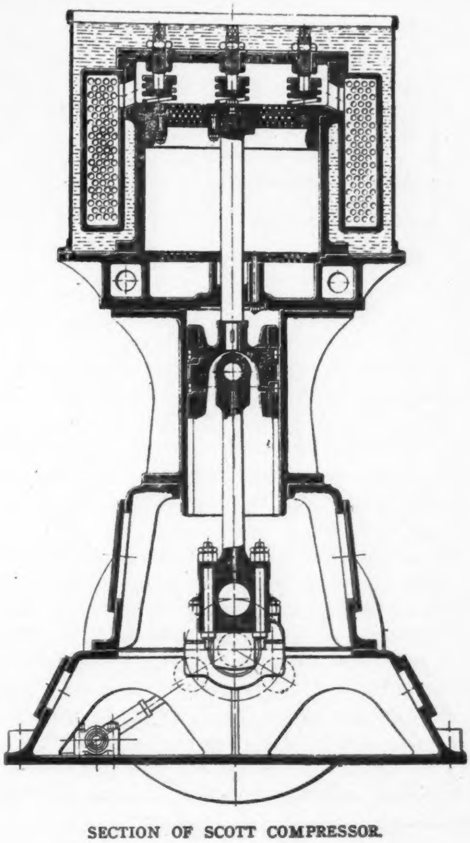
SCOTT AIR COMPRESSOR.

discharge through the cylinder head. The plate over the valves has holes corresponding to those in which the valves seat, but they are so located that the solid portions between the valves come directly over the balls, allowing a lift of only 1-16 in. It is not easily to be believed that all these valves can be all and always air tight.

The intercooler consists of a number of brass tubes expanded into tube plates in the ordinary way, and so arranged that the air is passed through the tubes on its way from the low to the high pressure cylinder, while the whole of the intercooler is immersed in the body of water in the tank.

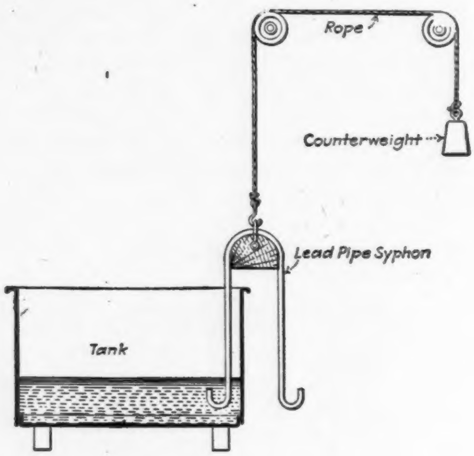
NEW YORK BARGE CANAL

A comparison between New York's $120,000,000 barge canal and the Panama Canal was made recently by John A. Bensel, state engineer of New York. The magnitude of the barge canal is not generally appreciated, Mr. Bensel said. The Panama Canal is a great engineering work, but we of the barge canal think that in many ways our project is as great, if not greater. The barge canal is 540 miles long and embraces between 350 and 400 structures. The Panama Canal is fifty miles long and has few if any structures besides six locks. While the construction is going on navigation is maintained along the barge canal, operations are entirely through contractors, and transportation facilities are not controlled. These difficulties are absent at Panama. In the case of the barge canal vested rights, property interests, legal complications, the need of guarding community interests and the prohibitive cost of acquiring rights so hedge in the engineer that his authority is limited. In Panama these obstacles are not encountered. While the total quantities of construction items on the barge canal are equal to about three-quarters of those on the Panama, the barge canal, including about fifty terminals, is being built for a little more than one-third the cost of the Panama. To supply the canal with water two great reservoirs have been built, the



SECTION OF SCOTT COMPRESSOR.

one at Delta being the larger. It is two miles wide and four miles long. Its capacity is 2,750,000,000 cubic feet. At Little Falls are the greatest series of high lift locks in the world. These five locks have lifts ranging from 32½ to 34 feet and a combined lift of 169 feet, or twice the total length from tide to summit of the Panama Canal. At Oswego is the first siphon lock in America. Contracts to the amount of about $82,000,000 have been awarded. These cover all but two or three per cent. of the whole length of the canal, and work to the value of about $56,000,000 has been completed.



A SIPHON ALWAYS READY

The sketch, which seems to require no explanation, comes to us from the Journal of the Chem. Met. and Min. Society of South Africa. The siphon is suspended with a counterweight as shown, and when the liquid in the tank, or any portion of it, is to be drawn the siphon is lowered into the tank as shown. To start the flow it is first necessary to fill the siphon which may be done by suction on the outer end, and then the liquid will continue to flow as long as the outer end is lower than the level of the liquid within the tank. If the flow is continued until the submerged end of the tube is uncovered all the liquid will run out of the siphon, and it will require recharging. It would seem also that in any case there should be some way of choking or stopping the flow of the siphon before lifting it out.

THE MINE TEPEPHONE

BY BERTON BRALEY.

"Ting—a—ling—a—ling,"
You can hear my noisy ring,
As it echoes in the chambers of the mine,
When I clearly come across
With the orders of the boss
Which are ripping in a volley down my line;
Though for miles the workings run
I have hitched 'em up as one,
I have made the mine a unit by my call,
From the busy bottom pump
To the breaker and the dump
I'm the blooming nervous system of it all!

"Ting—a—ling—a—ling,"
Hear the message that I fling,
"There's a cave in Number 20, send a crew,"
So they listen to my shout,
And they come and dig us out,
While without me 'twould be hours before they knew.
On my slender singing wire
Thrills the warning of the fire,
I give notice of the vapor's deadly breath,
And again and yet again
I have saved the lives of men
Who would otherwise have met a fearful death.

"Ting—a—ling—a—ling,"
You can hear my noisy ring,
With its tintinnabulation on the ear,
I'm the terror of the shirk
As I drive him on to work,
But when danger comes he's thankful I am here,
I'm the foe of all delay,
And I help to "make her pay,"
As a master of efficiency I shine,
From the cellar to the sump
I can keep 'em on the hump,
I'm the blooming nervous system of the mine.

—*Coal Age.*

A number of mines along the Monongahela river will be changed from electricity to compressed-air as a result of the Cincinnati mine explosion. The Department of Mines, through district inspectors, has ordered the changes. Safety-lamps have also been ordered to be used exclusively in future.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

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CONTENTS

THE INTERDEPENDENCE OF PUMPS AND COMPRESSORS

It will be noticed that in our present issue the most prominent article is one having to do with the manufacture of pumps for water, and some reader of COMPRESSED AIR MAGAZINE may be moved to remark as to the apparent anomaly. We have to confess that we do not really feel that any apology is required, or even a word of actual explanation to those sufficiently informed, but a gentle reminder as to the actual relations of water and compressed air in mining, tunneling and allied operations may not be out of place.

It is easy enough to say, and we are ready enough to say it, that the most essential agency in all subterranean operations of depth and magnitude is the rock drill, and that without it our modern mines and quarries, our tunnels and aqueducts could have no existence. But we might go further and say that the efficient rock cutting, or, rather, rock rending, devices of us moderns could not have their way unless the water was first removed and kept under control as the work advanced. In perhaps the majority of undertakings of magnitude the rock drill is dependent upon the pump for its right or ability to work. And this is true not only in preliminary work of all kinds but also in the works which are carried on with suggestion of permanency of occupation, as in mining operations in general. It has been noted in our columns quite recently that in some English mines 50 tons of water must be raised to the surface for each ton of mineral, and in the anthracite mines of Pennsylvania it is said that the profits would be increased many times over if the water which must be raised could be sold instead of the coal and at the same price per ton.

The water pump and the air compressor being thus such inseparable companions and such necessary co-operators in their daily work, it would seem to be the most natural thing in the world that the builder of the one as a business should also have the other active and ready on his list for the satisfaction and convenience of the customers to whom he caters.

If the manufacturers of mining machinery, so-called, including all devices employed in the cutting or rending of rock and its manipulation and conveyance, have not included in their detailed list of products one of the most essen-

tial classes of all the apparatus employed, there is no reason why COMPRESSED AIR MAGAZINE should ignore the pump industry.

GAS WELLS FOR AIR RECEIVERS

[The following occurs in a valuable paper entitled "Natural Gas, with Incidental References to Other Bitumens," by I. N. Knapp, M. E., printed in the Journal of the Franklin Institute, November and December, 1912.]

"At Chanute I used, for a few months, the natural gas under rock pressure from two wells for blowing or pumping oil wells and pumping from field tanks. I then put in gas engine driven air compressors to supply compressed air for the same operations.

"The rock pressure of the two wells had fallen from 305 to 125 pounds, and the gas then showed wet. I hitched these two wells on my air line as air receivers or compensators and restored the rock pressure to 290 pounds of air and drove back the salt water. In this way I could, for a while, use compressed air to many times the capacity of my compressors; also, I could shut down my compressors without affecting my field operations. This shows what, I believe, was a new adaptation for a reservoir of rock."

THE CHOICE OF EXPLOSIVES

Black blasting powder is stated to be best suited for work in which a gradual pushing or heaving effect is desired, such as in excavating cuts, quarrying soft rock or stone, and especially in quarries where large blocks of building stone are sought. In order to obtain the maximum efficiency, the charge must be well confined by suitable "stemming." Granulated nitro-glycerin powder is more effective, and gives better results than black blasting-powder, in soft and seamy rock, or in material that does not sufficiently confine the gases evolved. "Straight" nitro-glycerin dynamites, as a class, develop greater disruptive force than any of the other commercial classes of explosives tested by the United States Bureau of Mines; and for this reason they should be used for producing shattering effects, or for blasting tough or hard materials, whenever conditions permit. If the "straight" nitro-glycerin dynamites are found to be too violent for certain classes of work, the low-freezing, or the ammonia dynamites, which have lower rates of detonation, and hence less disruptive effect, are recommended. The low-freezing dynamites have the advantage of not freezing until exposed to a temperature of 35° F., or less; but, like all nitro-glycerin explosives, after they become frozen, they must be thawed before use in order to insure the most effective results. As the ammonium nitrate used in ammonia dynamite is deliquescent, this class of explosive absorbs moisture more readily than other dynamites, therefore it is necessary that care should be observed when storing this class of explosives in wet or damp places. The gelatin dynamites have been used to a large extent in wet blasting, such as in the removal of obstacles to navigation and in deep workings, and, as a general rule, they are best suited for these purposes.

LOW PRESSURE AIR AND TOO MUCH OIL

The following, from a letter by a correspondent of South African Mining Journal, tells its own story as to the conditions spoken of. The word "jumper" seems to be the local word for the drill steel or bit.

"Personally, I am of the same opinion regarding rock drilling with efficient air power to drive these machines, and as economical as possible; with good air, say, from 85-90 lbs., the miner has a better chance of doing better work, and better footage. I consider 60-65 lbs. air very inefficient, as in the first place the blow of the jumper is not strong enough to drill a hole with clearance for the next jumper to follow; it not alone blunts the jumper quicker but stops you from progress, and in some cases the holes are shorter than others, hence bad enough occurring; the jumper is only fit for use once, the corners are all knocked off, and this makes it impossible for further use. There has been a lot of trouble between the miner and the man in the power house. When the air is bad you ring and ring till you are blue. In not getting any response to air signals, I have come up and found 30, even 40, lbs. registering on gauge, yet the power house in every case logs 80 lbs.; this has been of very frequent occurrence. Trouble has arisen between the miner and drill sharpener; the drill sharpener considers the jumpers are not getting fair treatment, while on the other hand the miner is blaming the air, and

the way the drills are sharpened. I prefer the jumpers sharpened with a square face; this I have found to every advantage, both in collaring and drilling much faster, whereas on the other hand with a jumper having a rounded face, I find difficulty in starting and drilling a hole correctly, also the next jumper not following. Particularly is this so when drilling 7-8 feet hole it has often been the case. Say the diamond being used a second time, what with the jambing and low air pressure, and when it comes to the chisel this won't follow, then you use a half-worn chisel, and probably 6 in. to 9 in. of use you are compelled to abandon the hole, or chamber it, before rigging up again, which is often the case.

"It has happened to me scores of times when I have had to leave the machines, and come to the surface, and ask the man in the power house to give the air receiver a 'tap' the gas has been that bad from the compressor oil, making everyone ill. I have known on one mine where this used to occur regularly once a week, the miner and all his boys suffering from bad headaches, caused through the gas in the air. I complained to the managemnt on three occasions, and finally an investigation was made, *and there were taken 110 gallons of compressor oil out of the air receiver.* On another mine the air gave trouble again; one could not get more than 65 lbs. air, the rock being hard to drill, and using 12 holes for cut and round, this used to take three shifts sometimes before the round was down, and heavens knows we did work to get through. I maintain that unless the air registers 85-90 lbs. the work cannot be done as required."

THE "LITTLE DAVID" RIVETING HAMMER

The half tone shows one of the latest to be perfected of the extensive line of pneumatic tools of the Ingersoll-Rand Company.

This hammer is shorter than those of other makes with a like stroke. It is light, easy to handle, and has a very sensitive throttle control, making it specially suitable for drift-pin work. The valve chamber is independent of the piston chamber, which permits the use of pistons of different lengths without the liability of valve breakages so common in pneumatic hammers where the piston travels through the valve, or where the construction is such that the valve travels in line with the piston and is

LITTLE DAVID RIVETING HAMMER.

shifted by the piston compression. There is only one large port in the cylinder, which is equal in area to the usual multiple port construction and eliminates the liability of clogging.

The grip handle is of liberal size, and has a single lever throttle with a long bearing. The handle is attached to the cylinder by two bolts parallel with the cylinder. This insures perfect locking of the handle to the cylinder and precludes the necessity of using a vise for holding the tool when taking it apart. A single wrench is all that is required and taking apart or putting together again can be quickly done on floor or bench. The sand blast finish on both cylinder and handle prevents the hand slippages with hammers whose surfaces are polished.

The hammer is made in two sizes. No. 60 has a 6 inch stroke and will drive rivets up to 7/8 inch diameter, and No. 80 has 8 inch stroke, and is suitable for rivets up to 1 1/4 inch diameter.

OBJECTIONS TO HIGH FLASH-POINT OIL

At a meeting of the Association of Certified Mechanical Engineers (South Africa) one of the most important matters discussed was the lubricant of the compressed air cylinders used on the Witwatersrand. It was maintained that considerable quantities of harmful carbonaceous matter was liberated when the high flash point oil was used, and the air containing these impurities was liberated at the rock drills and pumps worked by compressed air, while the miners were at work. It was generally agreed that better lubrication could be obtained at much less expense to the mines by the adoption of oils having a lower flash point than that now demanded by the Government Mining Department, and that the use of such better oil would result in pure air and greater efficiency. The adoption of the "high flash point oil" was a "scare" movement after several explosions had taken

place in air compressors, but as the regulations now in force required the necessarily stringent hourly inspection of the temperatures of various parts of air compressors, the necessity for oils having a high flash point no longer existed. It was therefore unanimously agreed to apply to the Government Mining Engineer to allow the use of better lubricants, which while being cheaper were more efficient than those now demanded under the Mining Regulations, and would not deliver carbonaceous matter to the air mains or parts connected therewith.

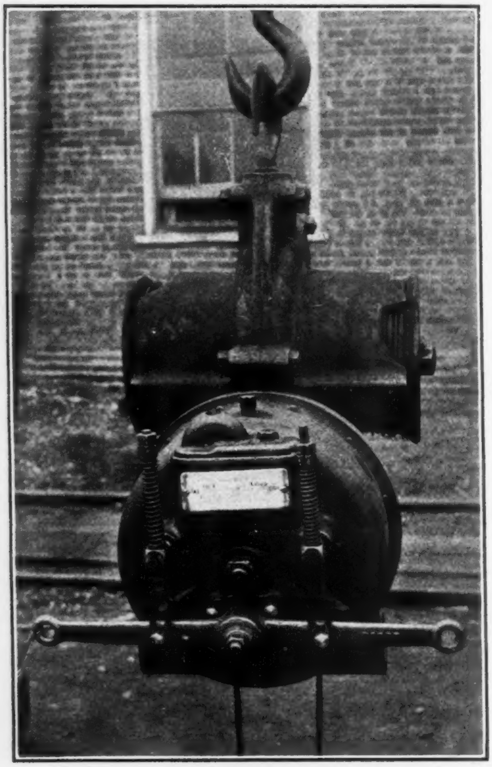


FIG. I. A VETERAN IMPERIAL HOIST.

IMPERIAL MOTOR HOIST HISTORY

The half tone (Fig. 1) shows an Imperial Motor Hoist at the shops of the Ludlum Steel Spring Company, Watervliet, N. Y., which has been in constant use since early in 1906, and is still doing excellent service. It has evidently had its share of accidents as well as inevitable wear. The guard covering the rope drum has been broken off on each side, and some repairs or replacements of working parts may have been required, but it is still "on the job."

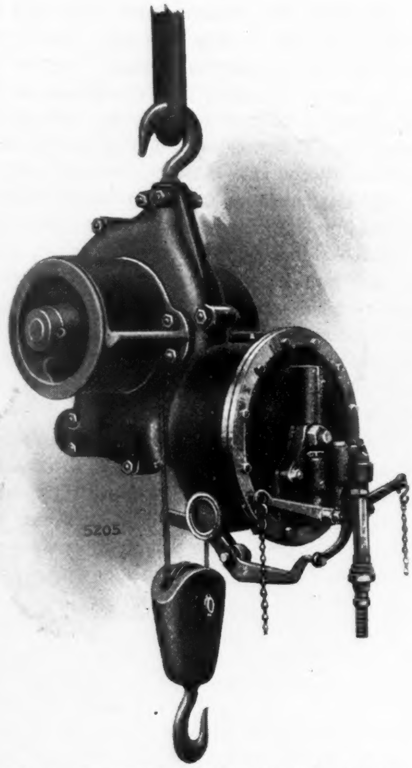


FIG. 2. UP-TO-DATE IMPERIAL MOTOR HOIST.

Fig. 2 is a view of a hoist of this type which is right up to date. It has been improved and redesigned all through, the valve arrangements being quite different in appearance as they are also in fact. The levers for hoisting and for lowering are separate and independent, and each permits perfect and delicate control. If the hoist lever is held open too long by the operator it is automatically provided that there shall be no over-lift and no damage can ensue from that cause. Both the hoisting and the lowering valves are normally always closed, and there can be no movement of the hoist either up or down, except in response to actual pull on the chain, and the load will no more run down than it will run up of itself.

While the rock drill has been constantly developing into increased efficiency, the associated means connected with the handling of the materials liberated by it have not been able to keep pace with it.

THE DIFFUSION OF GASES

If two gases be separately imprisoned in a vessel with a central sliding door between them, then when the door is removed, those molecules which were by the door will begin to diffuse into the next compartment. This power of diffusion varies inversely as the square root of the density of a gas. Thus if the two gases are oxygen and hydrogen the densities of which are 16 and 1, their diffusive energy will be as 1 to 4, and the first molecules of hydrogen will penetrate 4 ft. into the mass of oxygen in the same time as occupied by the molecules of oxygen in penetrating only 1 ft. into the mass of hydrogen. This diffusion runs counter to other influences and enables oxygen to find its way to the floor of a mine in spite of the superior gravitational pull upon the carbon dioxide. Thus diffusion and temperature-produced currents mix up the atmosphere, preventing gravitational stratification.

Since 14 cu.ft. of air weighs one pound and the atmosphere weighs upon each square inch about 15 lb. the height of the atmosphere, were it uniformly dense vertically, would be about 28,000 ft. And since its content of carbon dioxide is one in 10,000, this gas would cover the earth's surface to the depth of nearly three feet. No small animal could live at the sea level.

That we owe mixture to diffusion can be shown by removing the heat which gives to gas molecules this energy of motion. Gases liquify at different pressures and temperatures, and air can be separated into its constituents by compression at a very low temperature, the more easily liquified gases being drained off before the less easily liquified gases lose their gaseous state. The reverse effect, or distillation, has long been employed to separate mixed solids and liquids.

At a velocity of 1920 ft. per sec., a gas molecule, starting upward from the earth would ascend for

$$1920 \div 32 = 60 \textit{ sec.}$$

In that time it would reach a height of $16t^2$ ft., or

$$3600 \times 16 = 57{,}600 \textit{ ft.}$$

or 11 miles, which would be the depth of the atmosphere for a gas of that molecular velocity. The moon possesses little or no gas because its gravitation is insufficient to restrain the molecular energy with which gaseous molecules travel from it. With such a view of molecular gaseous energy it is obvious that gases cannot be much influenced by such movements as can be mechanically impressed upon them, and would-be revolutionaries in the engineering world would do well first to acquire a knowledge of some of the basic laws against which they may be running counter.—*W. H. Booth, in Power.*

HUMPHREY PUMP APPLICATIONS

Wide suggestion as to a further range of uses for his internal combustion pump was given by Mr. H. A. Humphrey in the course of his second lecture on this subject at the Royal Institution.

Mr. Humphrey said that in the application of his pump to the generation of electric energy the water was forced through an ordinary turbine, and brought back to the pump to be used over and over again, thus forming an hydraulic coupling between the gas explosion and the electric generator. In a battery of pumps the water was first delivered into large air vessels; these were interconnected both by air pipes above and by water pipes below, so that the pumps were all working in parallel, and any one pump might be stopped without interfering with the working of the turbine, to which the battery was supplying water. The complete control of the pumps from the switchboard and the freedom from the cyclic irregularities found in ordinary gas engines were great advantages. The special type of Humphrey pump for such work had a solid piston between the hot gases and the water surface, so that much more rapid action was possible, and a large power could be obtained from a pump occupying a comparatively small space.

Another application of the pump was in the propulsion of ships. The correct principles upon which this application could be made were described. In one type of Humphrey pump the water flowed continuously through the pump and received a number of forwarding impulses due to gas explosions at regular intervals. All the forces arising from the acceleration of water columns might be completely balanced; and one of their advantages for ship propulsion was that they would not cause vibration. A third application was in compression of air or other elastic fluids. Experiment has shown that an air compressor could be made absolutely self-regulating at all

pressures, such as were required for the blowing of blast furnaces, and as blast furnace gas could be used to work these compressors the arrangement should prove economical. Pumps for acid liquids and pumping from a deep well were described, and also an arrangement of balanced pumps, afloat on a barge, for delivering large quantities of water from a tidal river.

The first series of pumps took in water at the combustion chamber end and delivered it at the other end of the play-pipe. When modifications were introduced, making it possible both to take in and deliver water at the distant end of the play-pipe, it became possible to substitute for an oscillating column of liquid an oscillating solid piston of the same weight. In pumps where the liquids and gases were in contact the rate of retardation of the liquid during compression of the gas must not much exceed that figure corresponding to the rate of acceleration due to gravity, else liquid particles detached from the surface would rise freely into the gas space and spoil the thermal efficiency. This limitation did not apply in pumps having solid pistons, and to show what could be done in speeding up such a pump the lecturer mentioned that an experimental solid piston pump had been run at a speed of 193 cycles a minute.

DANGEROUS UNDERGROUND GASES

Dangerous underground gases include those that exert a poisonous or depressing effect on the human system and those that form inflammable or explosive mixtures with air.

In the air of properly ventilated mines operating under normal everyday methods, such an excess of carbon dioxide or such a deficiency of oxygen as would in itself cause harm is seldom encountered. However, at the working faces of some mines and in old workings there may be a deficiency of oxygen and an excess of carbon dioxide, as compared with normal mine air, that will prevent lamps from burning and be prejudicial to health. In addition, powder smoke may linger and the air may be so warm and moist that bad effects will be experienced by the miners.

Harmful proportions of carbon monoxide, hydrogen sulphide, and oxides of nitrogen are rarely present in mine air except at working faces where explosives have been fired. At working faces, however, as mentioned above, extremely harmful proportions of gases produced by blasting explosives are liable to be present for some time after a blast. Large quantities of carbon monoxide and carbon dioxide are then often produced; hydrogen sulphide also is sometimes formed. Oxides of nitrogen result from the improper detonation of certain classes of explosives. Immediately after a shot there may escape from the crevices produced by the blast both carbon monoxide and hydrogen so mixed with methane liberated from the coal as to make the mixture extremely inflammable. Carbon monoxide in deadly quantities is also formed by mine explosions and fires. Hydrogen, too, is produced under such conditions.

NOTES

When water is free to drop, it drops downward and not upward, although the half tones showing the Cochrane Separator in our issue for June seem to suggest the contrary. The separator is guaranteed to work all right only when **right side up.**

Waterwheels of the Pelton type for a head of 2,800 ft. have been installed in a hydro-electric plant at Aruiberg, Switzerland.

Natural gas has been found near Medicine Hat on the Canadian Pacific, the first well throwing out about 2,000,000 feet a day.

It is stated that the Curtiss Motor Company has perfected a motor developing more than 100 horse power with a total weight of only 310 pounds.

An oil engine that in Chicago, St. Louis or New York had produced 75 hp. could do no better than 40 hp. in South America, where the altitude was 11,000 to 13,000 ft. above sea level.

When a fly moves on the window pane it climbs going up and flies if going in a straight line downward. The fly never makes its decent walking on the surface of the glass. Hens invariably scrape gravel with their backs to the sun. Cats never expose their paws to the heat of the fire. In the majority of cases they

bring their left side toward the fire. Dogs, on the contrary, bring their paws as nearly as they can to the point from which the fire proceeds.

The huge Indian span of the old Kentucky and Indiana bridge across the Ohio at New Albany was dropped into the river recently by burning the bolts and fastenings with an oxy-acetylene burner.

Fifty thousand dollars' worth of radium was recently sold by the executors of Sir Julius Wernher, the South African millionaire. This sum was paid for half a gramme (.001102 lb., Avoirdupois).

The first railroad in Iceland is to be built in the next three years, according to a U. S. consular report. It will be about 6¼ miles long, extending around the city and harbor of Reykjavik, and costing about $500,000.

All predictions of past years that coal could not be worked at a greater depth than 1,500 feet, no longer hold water. At the present day, according to W. E. Garforth, president of the British Institute of Mining Engineers, coal is being mined at depths exceeding 3,000 feet. The adoption of a system of long-wall working has solved the question of superincumbent weight. The coal is exposed to this weight for a very short time and places are closed up rapidly.

A pint of gasoline left open in a basin in a room at a normal or average temperature will entirely evaporate in 24 hours. The gasoline vapor is heavier than the air and sinks immediately to the floor and unless it is disturbed by active air current will remain in the room for many hours. One pint of gasoline will make 200 cubic feet of explosive mixture. Without becoming too scientific, it may be said that this gasoline vapor is 7 times more powerful than gunpowder.—*Gas Power.*

Delegates from municipalites in all parts of Europe recently attended a demonstration in London of a new system of road cleaning by a patent dustless motor vacuum road-cleaning machine. It consists of a suction machine containing a stiff brush which revolves at great speed close to the ground, thus creating the suction necessary to remove every particle of dust, mud, or refuse in the road over which it passes. The refuse is automatically deposited in a covered bin at the back of the car, and the suction is so great that mud is withdrawn from the crevices between the stone blocks with which some roads are laid.

When natural gas is used as fuel under a steam boiler from 40 to 60 cubic feet per horse power hour will be required, while the same power can be developed by the consumption of from 9 to 15 cubic feet in a gas engine, so the use of gas under steam boilers at power plants is not to be encouraged, if, indeed, it should be permitted.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 6.

1,060,588. UNLOADING DEVICE FOR PUMPS. EDWARD H. DEWSON, New York, N. Y.

1,060,594. PUMP. WILLIAM U. GRIFFITHS, Philadelphia, Pa.

1,060,613. SLACK-ADJUSTER. JOHN OSBORNE MARS, Omaha, Nebr.

1,060,650. DIFFERENTIAL-PRESSURE GOVERNOR FOR PUMPS. WALTER V. TURNER, Edgewood, Pa.

1,060,651. OZONE-GENERATOR. ANDREW L. VAN PATTEN, Los Angeles, Cal.

1,060,815-6. PUMP. RALPH B. CARTER, Haworth, N. J.

1,060,826. COMBINED PNEUMATIC LIFT AND FORCE PUMP. FRANKLIN OSCAR DE HYMEL, San Antonio, Tex.

1,060,828. MILKING-MACHINE. HENRY DROUTLEGE, Ponsonby, Auckland, New Zealand.

1,060,852. VACUUM MASSAGE DEVICE. FRANK O. PARKER, Washington, D. C.

1,060,854. PNEUMATIC WHEEL. NIELS PETERSON, Teton, Idaho.

1,060,964. VACUUM-CLEANER. JAMES T. ATWOOD, Rockford, Ill.

1,060,935-6-7. CENTRIFUGAL AIR - PUMP. FRANZ JOSEF PETERMOLLER. Berlin, Germany.

1,061,034-5-6. PNEUMATIC-DESPATCH-TUBE RECEIVING-TERMINAL. BIRNEY C. BATCHELLER, N. Y, New York.

1,061,142. FLUID PROPULSION. NIKOLA TESLA, New York, N. Y.

1. A machine for propelling or imparting energy to fluids comprising in combination a plurality of spaced disks rotatably mounted and having plane surfaces, an inclosing casing, ports of inlet at the central portion of said casing and through which the fluid is adapted to be introduced to the axial portions of the disks, and ports of outlet at the peripheral portion of the casing through which the fluid when the machine is driven by power, is adapted to be expelled, as set forth.

1,061,181. AIR-COMPRESSOR. JUSTUS R. KINNEY, Dorchester, Mass.

3. In a device of the class described, the combination of a casing having two piston chambers therein, the outlet from one communicating with the inlet of the other; and rotary eccentric pistons in said chambers so positioned relative to each other that one will cut off the inlet to the second piston chamber while the piston in the first chamber is compressing.

1,061,203. HAMMER OPERATED BY COMPRESSED FLUID. CHARLES H. SHAW, Denver, Colo.

1,061,205. APPARATUS FOR PROPELLING FLUIDS. IRA H. SPENCER, West Hartford, Conn.

1,061,208. GOVERNING DEVICE FOR FLUID-COMPRESSORS. CHARLES WAINWRIGHT and FRED J. CARNEY, Erie, Pa.

MAY 13.

1,061,292. DUST AND FUME ARRESTER. JOHN P. HUNDRUF, Riverside, and WILLIAM G. ALLEN, San Francisco, Cal.

1,061,313. ARMORED PNEUMATIC TIRE. WILLIAM ROBERT MORRISON, Chicago, Ill.

1,061,350. STUMP-BURNER. WALTER CLIFFORD BECKHAM, Paxton, Fla.

1. A burner of the character described comprising an elongated body of U shaped form in cross section provided with a cylindrical extension upon one end, a plate connecting the side walls of said body at the inner end of said extension, the longitudinal edges of the U shaped portion of said body and the edge of said plate being adapted for engagement with a tree stump, a fuel bed supporting grate arranged between the side walls of the body at its lower end, *an air blast pipe* connected to said body to supply air to the fuel bed, and a draft pipe connected to the extension of the burner body.

1,061,404. GLASS-BLOWING MACHINE. JOHN RAU, Indianapolis, Ind.

1,061,474. POWER-DRILL. WILLIAM HARTEL, Cleveland, Ohio.

1,061,526. FEED AND DELIVERY ATTACHMENT FOR PRINTING-PRESSES. SAMUEL W. CORTISSOZ, Philadelphia, Pa.

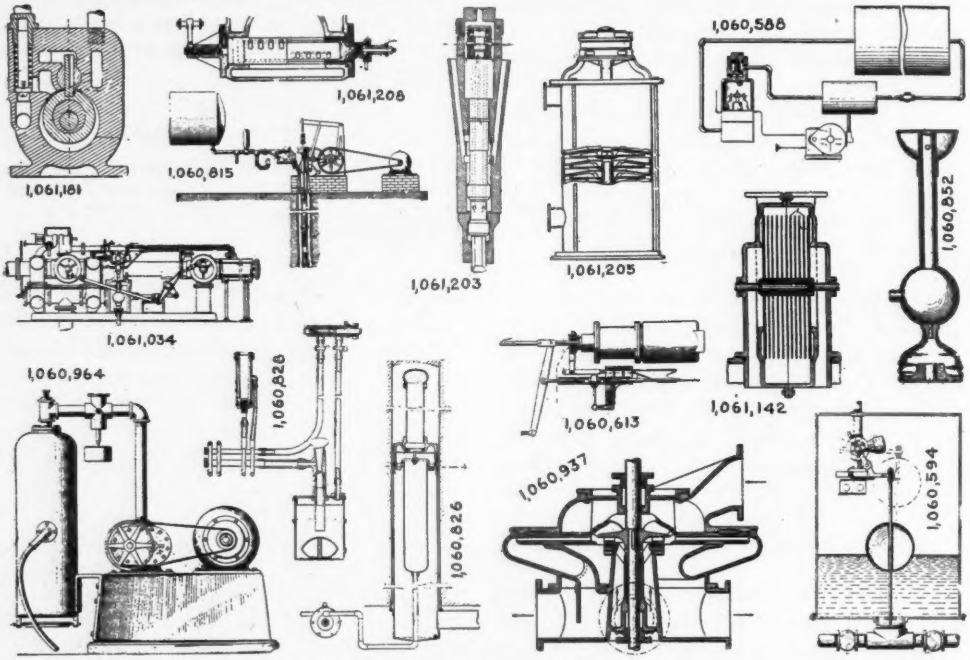
1. Apparatus of the class recited comprising a table operated through the instrumentality of pressure, said table containing articles to be fed, means for supplying pressure beneath said table for elevating the same vertically, a horizontally arranged endless conveyer, a reciprocating arm equipped with a suction device for transferring one at a time said articles from said table to the conveyer, a pneumatic device for relatively separating said articles prior to transfer, valved means responding to the removal of an article from the table for causing the admission of pressure beneath the table to elevate it a predetermined distance, means for reciprocating said arm and means actuated by the reciprocating arm for establishing and interrupting suction through said suction device.

1,061,537. VEHICLE - WHEEL. LUCIEN R. GRUSS, San Francisco, Cal.

1,061,539. APPARATUS FOR ADMINISTERING NARCOTICS. GEORG HAERTEL, Berlin, Germany.

1,061,689. GOVERNING MECHANISM FOR CENTRIFUGAL AIR-COMPRESSORS. RICHARD H. RICE, Lynn, Mass.

1,061,788. ROTATING MECHANISM FOR ROCK-DRILLS. CLARK J. SMITH, Ottumwa, Iowa.



PNEUMATIC PATENTS MAY 6.

1,061,792. ELASTIC-FLUID TURBINE. GEORGE WESTINGHOUSE, Pittsburgh, Pa.

1,061,839. FORGING-PRESS. HUGO HAISS, Marietta, Pa.

1,061,900. COMBINED HAND AND AIR BRAKE. WILLIAM J. CLELLAND, Watertown, N. Y.

MAY 20.

1,061,969-70. COMPOUND STEAM - PUMP. ROBERT C. AUGUR, Pitsburgh, Pa.

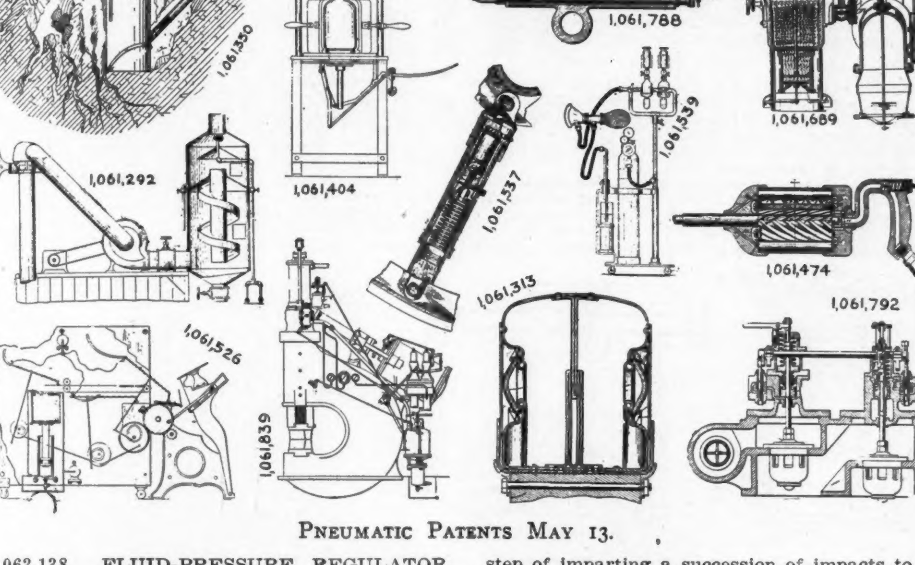
1,062,006. CENTRIFUGAL FAN OR PUMP. WALDEMAR HESSLING, London, England.

1,062,050. WELL-DRILLING APPARATUS. ALFRED C. STEWART, Los Angeles, Cal.

1. A well drilling apparatus comprising an open-bottomed caisson, means for lowering and raising said caisson, means for supplying compressed air to said caisson to maintain a portion thereof free of water, drilling devices located in said caisson and motive means for said drilling devices located adjacent the drilling devices and operating directly thereon.

1,062,104. PNEUMATIC PLAYER-PIANO. JOSEPH LEISCH, Tryon, N. C.

1,062,124. AIR-WASHER. SIDNEY RANDOLPH SHELDON, Galt, Ontario, Canada.



PNEUMATIC PATENTS MAY 13.

1,062,138. FLUID-PRESSURE REGULATOR. ROBERT N. BAYLIS, East Orange, N. J.

1,062,149. BLOWER. NELSON E. FUNK, New York, N. Y.

1,062,269. HUMIDITY - CONTROLLING APPARATUS. JOSEPH H. BRADY, Kansas City, Mo.

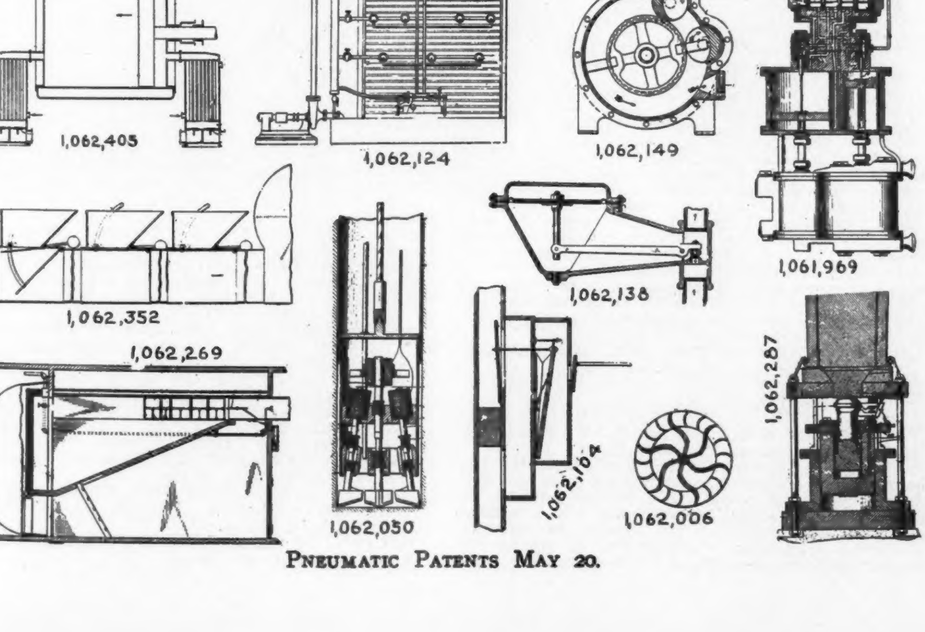
1,062,287-90. METHOD OF MAKING CASTINGS. DAVID MAXWELL, Detroit, Mich.

1. The method of casting, which includes the step of imparting a succession of impacts to the casting while pouring, and varying the character of the impacts.

1,062,352. PNEUMATIC CONVEYER APPARATUS. HARRY N. MIDDLETON, Philadelphia, Pa.

1,062,405. COMPRESSOR. ERNST WILHELM KOSTER, Frankfort-on-the-Main, Germany.

1. In a compressor, the combination with a compression cylinder and a piston arranged to travel in said cylinder to compress fluid therein,



PNEUMATIC PATENTS MAY 20.

of a cooler having a path one end of which has a constantly open communication with said cylinder, and means connected with the other end of said path, for controlling the admission and delivery of the fluid to and from said cylinder, so that the said fluid will travel through the same path of the cooler both on its way to the cylinder and on its passage therefrom.

MAY 27.

1,062,608. PRESSURE-AIR DEVICE. CHARLES SANDOZ-MORITZ, Tavannes, Switzerland.

1,062,662. ROCK-DRILL TESTER. WILLIAM D. PAYNTER, Grass Valley, Cal.

1,062,665. LOAD - CONTROLLING DEVICE. GEORGE M. RICHARDS, Erie, Pa.

1. In a load controlling device for fluid compressors, the combination of a casing having inlet and outlet portions which connect respectively with the compressor and with a receiver for the compressed fluid, and an escape opening, a check valve located between the escape opening and the receiver for retaining the pressure in the receiver, a valve cylinder located in said casing between said inlet and outlet openings, a load controlling valve located in said cylinder and adapted to open and close said escape opening, a by-pass adapted to transmit fluid pressure from the inlet portion of said casing to said cylinder, whereby the difference between the fluid pressures in the inlet portion and the escape opening of the casing is transmitted to said cylinder to move said controlling valve to close said escape opening, and means for returning the controlling valve when the pressure in said cylinder is reduced, substantially as set forth.

1,062,714. LIQUID-FUEL BURNER. ROBERT N. JOHNSTON, Denver, Colo.

1,062,749. PNEUMATIC TOOL. ISAAC W. TOWNSEND, Teague, Tex.

1,062,808. APPARATUS FOR JARRING AND PRESSING GRANULAR MATERIALS. HENRY TSCHERING, Freeport, Ill.

1. In apparatus of the class described, the combination with a cylinder having inlet and discharge passages below, of a piston working in the cylinder, a spring-closed valve and a second valve each controlling the discharge opening when the companion valve is closed, means for admitting compressed fluid below the piston constantly or intermittently as desired, a manually operated member arranged to be swung into or out of a normal position, and means whereby the spring-closed valve is held open only while said member is out of said position.

1,062,837. VACUUM CLEANING DEVICE. HERMAN B. MERTZ, Beach View, Pa.

1,062,855. AIR-GUN. ERNEST S. ROE, Plymouth, Mich.

1,062,856. REFRIGERATING APPARATUS. JOSEPH SCHNEIBLE, Chicago, Ill.

1,062,904. FLUID-PRESSURE MOTOR. JOHN FOURNIA, Albany, N. Y.

1,062,927. AUTOMATIC PIPE CONNECTION. JOHN W. ROBERTS, Sarnia, Ontario, Canada.

1,062,963. APPARATUS FOR RAISING SUNKEN VESSELS. THOMAS HECTOR GAWLEY, New Orleans, La.

An apparatus for raising sunken vessels comprising a header adapted for connection to the container of an air compressor and having a plurality of valve controlled nipples, a plurality of compressed air tanks, means for connecting said tanks in pairs and admitting of their disposition on opposite portions of the vessel to be raised, a plurality of flexible tubes carried by the nipples, a plurality of tubes carried by the tanks, Y-couplings connecting certain of the first with the second named tubes, sealing plates secured in the hatches of the vessel, nozzles extending through said plates and connected to the other of the first mentioned conduits, and discharge conduits also secured in said plates.

1,062,974. OZONIZER. NEVIL MONROE HOPKINS, Washington, D. C.

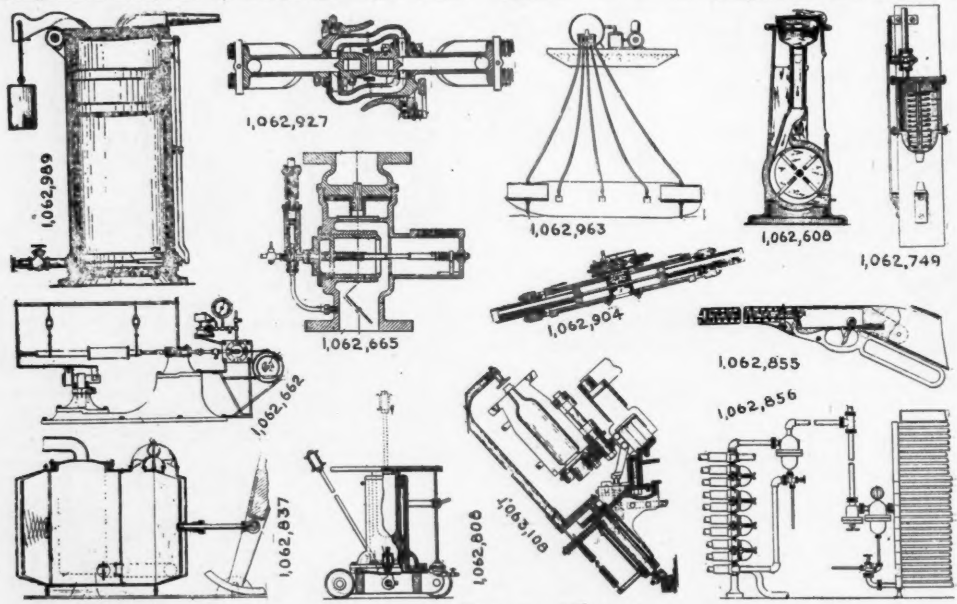
1,062,989. SAFETY APPLIANCE FOR SAUSAGE-STUFFERS. CHARLES NAEGELEN, Cincinnati, Ohio.

1,063,034. PROCESS OF AND APPARATUS FOR RAREFYING AND COMPRESSING AIR AND GASES BY MEANS OF LIQUID ACCELERATED BY A ROTOR-WHEEL. CARL HERMANN JAEGER, Leipzig, Germany.

1,063,072. AIR - RIFLE. ELBERT HAMILTON SEARLE, Springfield, Mass.

1,063,081. APPARATUS FOR THE PRODUCTION OF AIR-GAS. WALTER THIEM, Halle-on-the-Saale, Germany.

1,063,108. GLASS-BLOWING MACHINE. WILLIAM EMIL BOCK, Toledo, Ohio.



PNEUMATIC PATENTS MAY 27.